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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

A Large British Drag-Line Excavator (With a Two-Page Drawing).

The Road Congress at Seville.

The Helicopter Competition.

The Gas Turbine in Theory and Practice (No. III).

The Iron and Steel Institute.

Electrification of a S. American Railway.

The Kelvin Lecture.

A Solid-injection Crude Oil Engine.

PUBLIC NOTICES

WAR DEPARTMENT SALE OF E.I. GENERATING SETS.

Tenders are Required for the PURCHASE of the undermentioned MACHINERY:—

TWO 35 K.W. GENERATING SETS, each set consisting of:

(a) Vertical Semi-Diesel Twin-cylinder Oil Engine, 65/80 B.H.P., r.p.m. 330, complete with Cooling Tanks, Oil Tank, Piping and Spares, by the Keighley Gas and Oil Engine Company, Limited, belt driving.

(b) Generator, D.C., 230 volt, compound wound, r.p.m. 1100, by the Brush Electrical Engineering Company, Limited: and

(c) Switchboard and Accessories complete.

All now lying at West Fenton Aerodrome, Drem, Haddington, N.B.

Forms of Tenders, conditions of sale, and all necessary information, with order to view, may be obtained upon application to the Officer i/c Royal Engineer Stores, Piershill Barracks, Edinburgh, up to the 30th May, 1923.

Tenders to be forwarded to the CHIEF ENGINEER, Scottish Command, 23, North Bridge, Edinburgh, according to instructions noted on Tender form.

S. H. POWELL, Colonel,
Chief Engineer, Scottish Command.

Headquarters,
12th May, 1923. 2510

The Government of Zanzibar has FOR SALE GENERATING PLANT, consisting of Three Bellies and Morcom Enclosed Compound Engines, 13in. and 22in. by 9in. stroke, 400/420 r.p.m., designed to give 260 B.H.P. at 125 lb. steam pressure, direct coupled to Compound Wound D.C. Generators, by the Electric Construction Co., to give 175 K.W. at 240 volts. Also Four Smoke-tube Boilers, each 150 H.P., One Wheeler Condenser, Water Heater, and Feed-water pumps.

This plant is at present at Zanzibar, but further particulars may be obtained from the CROWN AGENTS FOR THE COLONIES, Engineering Contracts Department, 4, Millbank, Westminster, S.W. 1.

Offers to purchase should be addressed to the CROWN AGENTS FOR THE COLONIES. 2493

In the High Court of Justice. No. 00298 of 1923.
Chancery Division.
Mr. Justice P. O. Lawrence.
In the Matter of CUBITTS' ENGINEERING COMPANY Limited
and
In the Matter of The COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that by an ORDER dated the 14th day of May 1923 the Court has directed separate meetings to be convened of

(1) the Ordinary Unsecured Creditors of the above-named Company
other than (a) Preferential Creditors
(b) Creditors for under £10 and
(c) Creditors for Loans
(2) Creditors of the said Company for Loans
(3) the holders of Preference Shares of the said Company and
(4) the holders of Ordinary Shares of the said Company

for the purpose of considering and if thought fit approving with or without modification a Scheme of Arrangement proposed to be made between the said Company and the said Company's aforesaid Ordinary Unsecured Creditors, Creditors of the said Company for Loans and the holders of Preference Shares and the holders of the Ordinary Shares respectively of the said Company and that such meetings will be held at Winchester House Old Broad-street in the City of London on Friday the 1st day of June 1923 at the times below mentioned namely:—

the meeting of the aforesaid Ordinary Unsecured Creditors of the Company (other than those heretofore excepted) at 11.30 o'clock in the forenoon
the meeting of the Creditors for Loans at 12.30 o'clock in the afternoon or so soon thereafter as the preceding meeting shall have been concluded
the meeting of the Preference Shareholders at 2 o'clock in the afternoon or so soon thereafter as the preceding meetings shall have been concluded
the meeting of the Ordinary Shareholders at 3 o'clock in the afternoon or so soon thereafter as the preceding meetings shall have been concluded

at which place and respective times all the aforesaid Ordinary Unsecured Creditors (other than those heretofore excepted) the aforesaid Creditors for Loans the aforesaid holders of Preference and of Ordinary Shares are respectively requested to attend.

Such Ordinary Unsecured Creditors, Creditors for Loans, Preference and Ordinary Shareholders may attend such meetings respectively and vote thereat either in person or by proxy but all forms appointing proxies must be deposited with the Company at its registered office situate at 56 Conduit-street in the County of London not later than 12 o'clock noon on Thursday the 31st day of May 1923. In the case of joint holders of Preference or Ordinary Shares the person whose name stands first in the Register in respect thereof shall alone be entitled to vote at the meetings. In the case of joint holders voting by proxy the forms of proxy must be signed by each of the joint holders. The person appointed to act as proxy must himself be a member of the same class as the appointor.

A copy of the said Scheme of Arrangement can be seen at the aforesaid registered office of the Company. Forms of proxy may be obtained from the Secretary of the Company.

The Court has appointed William Greenwood M.P. or failing him Francis Richard Wade Chairman of the Meeting of the aforesaid Ordinary Unsecured Creditors Edward Charles Hannen or failing him John Barr Stevenson (of Holland Hannen and Cubitts Ltd.) Chairman of the meeting of the aforesaid Creditors for Loans Henry Sneyd Horne or failing him Frank Maitland May Chairman of the meeting of the aforesaid Preference Shareholders and Henry Sneyd Horne or failing him Edward Charles Hannen Chairman of the meeting of the aforesaid Ordinary Shareholders.

The said Scheme of Arrangement will be subject to the subsequent approval of the Court.

Dated this 15th day of May 1923.

CLIFFORD TURNER and HOPTON,
81/7, Gresham-street, London, E.C. 2,
2513 Solicitors to the above-named Company.

University of Birmingham.
JAMES WATT RESEARCH FELLOWSHIP.

The Council invites APPLICATIONS for the JAMES WATT RESEARCH FELLOWSHIP in the Thermo-Dynamics of Internal Combustion Engines. Candidates should hold an Honours Degree in Engineering of a British University, and have had some experience in research. The Fellowship has at present an annual value of £220 and is renewable. Applications should be sent in not later than 31st of May, 1923.

Further particulars may be obtained from the Dean of the Faculty of Science, The University, Edgbaston, Birmingham.

GEO. H. MORLEY,
2414 Secretary.

PUBLIC NOTICES

The University of Sheffield.
PROFESSORSHIP OF MECHANICAL ENGINEERING.

The Council of the University invite APPLICATIONS for the above POSITION, shortly to become vacant.

Applications should be received by the undersigned, from whom further particulars may be obtained, by the 12th June.

W. M. GIBBONS,
2532 Registrar.

City and Guilds (Engineering) COLLEGE, S.W. 7.
ASSISTANT PROFESSORSHIP IN ELECTRICAL ENGINEERING DEPARTMENT.

Owing to the appointment of Dr. Parker Smith to the Chair of Electrical Engineering at the Royal Technical College, Glasgow, the Delegacy will proceed shortly to the APPOINTMENT of an ASSISTANT PROFESSOR to deal particularly with the Traction and Design Sections of the Electrical Engineering Department. Candidates for the post will be expected to have had some experience of this work. Applications must be received not later than 31st May.—Full particulars can be obtained from the SECRETARY to the DELEGACY, The City and Guilds (Engineering) College S.W. 7. 2480

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY

APPOINTMENT OF A LECTURER IN MUNICIPAL & SANITARY ENGINEERING.

The Governing Body invites applications for a Lectureship in Municipal and Sanitary Engineering in the College of Technology.

Salary: £400 per annum.

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester. The last day for the receipt of applications is Wednesday, 6th June, 1923.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment. 2470

Manchester Corporation Tramways.

The Tramways Committee of the Manchester Corporation are prepared to receive TENDERS for the SUPPLY, DELIVERY, and ERECTION of a SAND DRYING APPARATUS. Specifications and forms of Tender may be obtained on application to Mr. Henry Mattinson, General Manager, Corporation Tramways, 55, Piccadilly, Manchester. Tenders are to be addressed to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, endorsed "Tender for Sand Drying Apparatus," and must be received not later than 10 a.m. on Tuesday, the 12th June, 1923.

The Committee do not bind themselves to accept the lowest or any Tender.

P. M. HEATH,
Town Clerk.
Town Hall, Manchester,
19th May, 1923. 2530

"THE ENGINEER" WANTED.

WANTED, a COPY of "THE ENGINEER" Dated December 26th, 1919.—Address, P5002 The Engineer Office. P5002

PUBLIC NOTICES

City of Nottingham.

The Works and Ways Committee are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES and MATERIALS, the contracts to commence on the 1st July, 1923, and to terminate on the 31st March, 1924.

A. Cement.
B. Blue Lias Lime.
C. Red Bricks.
D. Blue Bricks.
E. Timber.
F. Stoneware, Pipes, &c.
G. Stoneware, Pipes, &c. (Patent Joints).
H. Iron Castings, Iron Gullies, &c.
I. Yorkshire Flags, Kerb, &c.
J. Granite Setts, Kerb and Broken Granite.
K. Ironstone Slag, Chippings, &c.
L. River Gravel.
M. Picks, Shovels, Scoops, &c.
O. Ironmongery.
P. Scavenging and other Brushes.
Q. Disinfectants.
R. Refined Tar.
S. Pitch.
T. Creosote Oil.

Forms of Tender may be obtained on applying to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of a deposit of 5s. each, which will be returned on receipt of a bona fide Tender in accordance with the specifications, providing each Tender is not withdrawn and is delivered by the time stated below.

Patterns and samples may be inspected at the Eastcroft Depot, London-road, Nottingham.

The Committee will not consider any Tender except on the authorised form of Tender, which must be delivered to the undersigned, in the official envelope provided, on or before Thursday, 7th June, 1923.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be accepted from persons who conform to the conditions as regards paying the local standard rate of wages, &c., and to the working rules of the Nottingham district, applicable to the various trades.

By Order,
W. J. BOARD,
Town Clerk.
Guildhall, Nottingham,
12th May, 1923. 2490

East Indian Railway.

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 30th May, TENDERS for the SUPPLY of:—

(1) HAIR BELTING.
(2) MAGNESITE BRICKS.
(3) MATERIALS for STEEL FOUNDRY (Aluminium, Blackhead in Bars, and Ground Canister).
(4) SILICA FIRE-BRICKS.
(5) WHITE LEAD.

Copies of the specifications can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. E. LILLIE,
Secretary.
73-76, King William-street, London, E.C. 4.
16th May, 1923. 2521

Epsom Rural District Council.
STEAM ROLLERS.

The above-named Council invite TENDERS for the SUPPLY of TWO NEW STEAM ROAD ROLLERS, 10 and 15 tons, fitted with SCARIFIERS, delivered at Ewell Station (L. and S.W. Ry.).

Full particulars and dimensions of rollers offered and date of delivery to be sent to Mr. T. E. Ware, Surveyor to the Council, Waterloo-road, Epsom, and sealed Tenders, addressed to the Chairman of the Council, Grasdale, Waterloo-road, Epsom, to be delivered not later than Wednesday, the 30th instant.

The Council do not bind themselves to accept the lowest or any Tender.

By Order,
(Sgd.) ARTHUR R. COTTON,
2516 Clerk.

PUBLIC NOTICES

Great Southern and Western RAILWAY (IRELAND).
CONTRACTS, 1923.

The Directors of the Great Southern and Western Railway Company are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES for three months commencing 1st July, 1923, and alternatively for six months commencing the same date.

	No. of Form.		No. of Form.
Acid, Sulphuric	3D	Glass, Sheet and Plate	27A
Asbestos Sheeting, &c.	40	Glass and China Sundries	27B
Baskets	10	Hardware (Sundry)	17
Bolts, Nuts, and Rivets	15	India Rubber Goods	9A
Brooms and Brushes	13	Implements, Sundry	21
Brass Fittings for Carriages	18	Iron Tubes and Fittings	29
Do. do. for Water	28A	Leather and Leather Goods	12
Do. do. for Gas	28B	Locks and Keys	19
Canvas and Sacks	6	Mats, Fibre	10
Canvas for Wagon Tarpaulins	6A	Nails	31
Castings, Mall. Iron	11	Packings	40
Carriage Laces	7A	Plumbago	41
Cloth for Carriages	7C	Rain Water Pipes and Gutters	25
Clothing, I.R. proofed	9B	Ropes, Twine and Flax	4
Coach Screws and Washers	15	Soaps	30
Colours	2	Sewer Pipes, Plaster of Paris, &c.	32
Corks	39	Shovels, Spades, &c.	21A
Cotton Waste	5A	Sponge Cloths	5
Crucibles	41	Signal Wire Pulleys	11
Drysalteries	3	Screws and Split Pins	14
Emery and Glass Cloth, &c.	22	Tin Plates	27
Files and Tool Steel	20	Waste	5A
Fire Bricks and Clay	23	Waterproof Clothing	9B
Foundry Requisites	42	Wicks	5
Galvanised Sheets, Buckets, &c.	23	Wire, Fence and Signal	30A
Grates, Stoves	24	Wirework	30B
Grindstones	28		

Forms of Tender can be obtained on payment of 6d. each from the Stores Superintendent, General Stores Department, G.S. and W.R., Inchicore, Dublin. Applications for forms by post must be accompanied by postal order. Stamps cannot be accepted. All inquiries for information should be also directed to the Stores Superintendent.

Patterns may be inspected at the General Stores Department on and after the 21st inst., between the hours of 10 a.m. and 4 p.m. (except on Saturdays).

Tenders must be enclosed in the special envelope supplied for the purpose with each schedule, and must be posted so as to be with the undersigned before 10 a.m. on Wednesday, 6th June, 1923.

The Directors will not consider any Tender unless it is furnished on the Company's form, and do not bind themselves to accept the lowest or any Tender.

By Order,
ROBERT CRAWFORD, Secretary.
Kingsbridge Terminus, Dublin, May, 1923. 2482

Department of Public Works
Sydney, 31st January, 1923.
SYDNEY HARBOUR BRIDGE TENDERS—
EXTENSION OF TIME.

Tenders are Invited by the Government of New South Wales for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of a CANTILEVER BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1600ft. in the clear, centre to centre of main piers, and a length of main bridge 3800ft. centre to centre of anchor piers. The total length of main bridge and approach spans included in Tender is 5410ft.; also an ALTERNATIVE TENDER for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of an ARCH BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1650ft. in the clear, centre to centre of bearings. The total length of main bridge and approach spans included in Tender is 3770ft. Either bridge is to provide for four lines of railway, six lines of vehicular traffic, and footway accommodation.

Copies of specification, including plans, technical information, general conditions, and Tender forms, may be obtained by bona fide tenderers on application to the Under-Secretary for Public Works, Sydney, or to the Agent-General for New South Wales, Australia House, The Strand, London; the Minister of Railways and Canals, Ottawa; the Australian Trade Commissioner in the United States, New York; or the Bureau of Foreign and Domestic Commerce, Washington, D.C., United States.

Tenders, the time for which has been extended, must reach the Under-Secretary for Public Works, Sydney, New South Wales, not later than 30th November, 1923.

R. T. BALL,
2035 Minister for Public Works and Railways.

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PUBLIC NOTICES

Port of Bristol.

RECONSTRUCTION OF TRANSIT SHED "U." BRISTOL.

The Docks Committee invite TENDERS for the RECONSTRUCTION mainly in ferro-concrete of the DOUBLE-FLOOR TRANSIT SHED known as Shed "U," situate on Canon's-road, Bristol.

On and after Monday, the 28th day of May, 1923, a copy of the forms of Tender, general conditions, specification, schedule of prices, and a copy of the contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the General Manager and Secretary of the Docks Committee, to whom all cheques must be made payable. The deposit of £5 will be returned hereafter to all bona fide tenderers.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Reconstruction of Shed 'U.' Bristol," and addressed to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Monday, the 18th day of June, 1923.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Engineer,
Port of Bristol.

Chief Engineer's Office,
Avonmouth Docks,
16th May, 1923. 2415

Swansea Union.

CENTRAL HEATING SCHEME—TAWE LODGE, SWANSEA.

The Guardians invite TENDERS for the following, viz.:—

(A) 1. BOILER and CALORIFIER HOUSE.
2. STACK.
3. PIPE TRENCHES.
and
(B) 1. CENTRAL PLANT.
2. HEATING and DOMESTIC HOT WATER SERVICE.
3. RE-EQUIPMENT of LAUNDRY.

Further particulars may be obtained on application to me not later than 24th May, 1923.

LLEWN. JENKINS,
Clerk.

Union Offices,
Alexandra-road, Swansea,
11th May, 1923. 2466

The Great Indian Peninsula

RAILWAY COMPANY.
ELECTRIFICATION OF BOMBAY SUBURBAN LINES.

The Directors are prepared to receive TENDERS for the SUPPLY of certain PLANT in connection with the first instalment of the electrification of the above lines, namely :—

	Fee for Specification.
1. MOTOR BOGIE TRUCKS	£2
2. BONDS	£1

Specifications and forms of Tender may be obtained at this office on and after 23rd May, 1923, on payment of the fee for the specification, which payment will not be returned. Contractors may Tender for either or both of the above sections.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Bonds," or as the case may be, not later than Eleven o'clock a.m. on Thursday, the 28th June, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

The Consulting Engineers, to whom applications for any further technical information may be made, are Messrs. Merz and McLellan, 32, Victoria-street, Westminster, S.W. 1.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 16th May, 1923. 2522

The South Indian Railway Com-

PANY, Limited, are prepared to receive TENDERS for the SUPPLY of :—

1. STEEL RAILS and FISH-PLATES.
2. STEEL BEARING PLATES for F.B. RAILS.
3. LAVATORY FITTINGS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Steel Rails and Fish-plates," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 1st June, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specification No. 1, and of 5s. for each copy of Specifications Nos. 2 and 3.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1.
15th May, 1923. 2520

Urban District Council of

ENFIELD.

The Council are desirous of PURCHASING SECOND-HAND MACHINERY as follows :—

TWO Double-Inlet, Double Standard Belt-driven CENTRIFUGAL PUMPS, either 4in., 5in., or 6in. bore.

ONE VERTICAL CROSS-TUBE BOILER of about 6 H.P., 60 lb. pressure, complete with all Fittings and Mountings.

The above to be delivered to the Council's Sewage Farm, Cuckoo Hall-lane, Lower Edmonton, N.

Tenders, including a copy of last inspection certificate for the boiler, to be delivered to the undersigned not later than Twelve Noon on Monday, 21st May, 1923.

By Order,
T. W. SCOTT.
Clerk to the Council.

Public Offices,
Enfield, Middlesex.
9th May, 1923. 2461

Administrative County of

LONDON.
COUNTY HALL—ENGINEER-IN-CHARGE.

APPLICATIONS are INVITED by the London County Council for the POSITION of ENGINEER-IN-CHARGE of MACHINERY, &c., at the County Hall, at a salary commencing at £350 a year and rising by six annual increments of £15 and a final increment of £10 to £450 a year.

The foregoing scale of salary is based on pre-war conditions and is at present subject to temporary additions on the Civil Service scale, fluctuating according to the cost of living and making the total commencing remuneration £377 a year. The next revision of the temporary additions will take place not later than 1st September, 1923.

The person appointed to the position will be required to reside in the immediate vicinity of the County Hall, and if at any time quarters are provided for him at the County Hall he will be required to reside in them and to pay such rent therefor as may be fixed by the Council.

Members of the Council's staff are not precluded from submitting applications.

Candidates must not be less than 30 or more than 45 years of age, on the latest date for receiving applications, and unless they served with His Majesty's Armed Forces during the Great War must be natural-born British subjects. Due weight will be given to the claims of those applicants who served, or attempted to serve, with His Majesty's Forces during the war.

Apply for form (containing full details) to the Clerk of the Council, The County Hall, Westminster Bridge, S.E. 1. Stamped addressed foolscap envelope necessary. Forms must be returned not later than 4 p.m. on 4th June, 1923. Canvassing disqualifies.

JAMES BIRD,
2479 Clerk of the London County Council.

PUBLIC NOTICES

NOTICE.

Alexandria Municipality.

APPOINTMENT OF ASSISTANT ENGINEER, CHIEF OF ROADS SECTION.

The Municipality invites APPLICATIONS for a VACANT POST of ASSISTANT ENGINEER of ROADS SECTION.

Applications must reach the Municipality by the 20th June, 1923, and must be sent in a double envelope, the outer one addressed to the "Director-General, Alexandria Municipality, Alexandria, Egypt," and the inner one inscribed "Application for the Post of Assistant Engineer, Chief of Roads Section."

The appointment is guaranteed for 4 years, with the option for the Municipality of renewal for further periods of 2 years at a time.

The salary is fixed at £E600 per annum, with increases of £E60 per annum every two years in case of satisfaction, up to a maximum of £E780.

Minimum age 30.

Applicants must attach to their applications :—

(A) Birth certificate or other document in lieu of it ;
(B) Certificate of good conduct ;
(C) Diploma of Civil Engineer of a recognised school ;
(D) Certificates or other documents testifying that they have regularly attended the course of the school of which they possess the diploma, and that they have had a practical experience as engineer for at least 3 years.

Candidates must be specialists in urban road construction and upkeep and be well posted in up-to-date methods.

A knowledge of English or French is indispensable.

(S.) H. HOPKINSON,
Director-General.

Alexandria, the 29th March, 1923.

P.S.—According to the regulations in force for appointments on the municipal staff the candidate chosen will not be definitely appointed until he is examined by the Medical Commission and found in good health with a normal eyesight.

Applicants from abroad must enclose a medical certificate duly legalised by a competent authority and also a photograph. 2182

Borough of Bethnal Green.

ASSISTANT ENGINEER.

The Council invites APPLICATIONS for the APPOINTMENT of ASSISTANT ENGINEER at its Public Baths and Washhouses at a wage of £4 10s. per week, subject to deductions for superannuation.

Candidates must not be more than 40 years of age, have had experience of boilers, calorifiers and pipe work, and be members of the Amalgamated Engineering Union. Preference will be given to men resident in Bethnal Green.

Applications, on forms which will be forwarded on receipt of a stamped addressed envelope, must reach me at the Town Hall, Bethnal Green, E. 2, endorsed "Assistant Engineer," not later than Twelve Noon on Monday, 28th May, 1923.

Canvassing will disqualify.

DAVID J. KEEP,
2518 Town Clerk.
14/5/1923.

South African Railways Elec-

TRIFICATION.

APPLICATIONS are INVITED for the following POSITIONS :—

ENGINEERS, to Supervise the Erection and Starting to Work of large capacity Electric Locomotives. Salary from £600 to £850, according to qualifications and experience, plus passage from England and two or three years' engagement.

ASSISTANT ENGINEER, to Supervise the Erection of the Mechanical Equipment of the Power Station. Experience in the erection of large generating units is essential. Salary £600 plus passage from England and two years' engagement.

Applications, by letter only, with copies of testimonials, marked "Locomotives" or "Power Station," stating name, age, education, engineering training, and details of practical experience, must be received by Messrs. Merz and McLellan, 32, Victoria-street, London, S.W. 1, England, not later than the 20th June, 1923.

Applications from candidates in South Africa should be submitted to Messrs. MERZ and McLELLAN, c/o The General Manager, South African Railways and Harbours Administration, Johannesburg, not later than May 31st, 1923. 2485

SITUATIONS OPEN

WANTED, a Young and Active ENGINEER, with Rolling Mill Experience (Bars and Strip), to act as Efficiency Supervisor and track down all causes of waste. Must be a good organiser and have tact and adaptability.—Apply, stating fully, experience and salary required, to the WHITEHEAD IRON and STEEL CO., Ltd., Tredegar. P7462 A

WANTED, ASSISTANT MANAGER by Well-known Gear Makers ; must have good all-round knowledge of Machine-cut Gearing and previously held similar position. Age about 35 years.—Address, 2487, The Engineer Office. 2487 A

WANTED, SUPERINTENDENT for Electrical Engineering Factory. Applications are invited only from men with actual experience in controlling all departments of a works manufacturing standard machines in quantities on repetition work. Must be disciplinarian and used to working to a manufacturing programme against delivery dates. State age, experience, and salary.—Address, 2411, The Engineer Office. 2411 A

ADVERTISING MANAGER WANTED. Must have large experience in Journalistic Advertisements and Compilation of Booklets. Would also be expected undertake purchase of stationery.—Address, with full details of experience, stating salary, 2528, The Engineer Office. 2528 A

A POST WORTH £5 PER WEEK.—TRAVELLERS REQUIRED, with sound connections amongst Motor and General Engineers, Garages, Ironmongers and Dealers throughout Great Britain to sell a new make of Spring Lock Washer as a side line on 20 per cent. commission basis. Only men of proved selling ability need apply. State exactly in first letter details of experience, ground covered, age, &c.—Address, 2498, The Engineer Office. 2498 A

ASSISTANT ENGINEER, Canals ; Must Have a good knowledge of Engineering, Surveying, &c., and accustomed to the control of men.—Address, stating age, experience, and salary required, 2450, The Engineer Office. 2450 A

COLD STARTING OIL ENGINES.—Firm Manufacturing high-class Gas Engines open to APPOINT DESIGNER with first-class experience to develop above. State age, experience and salary required. Preference given to gentleman with capital who would share in results.—Address, 2472, The Engineer Office. 2472 A

ENGINEERS' CHEMIST to Take Charge of Laboratory ; practical experience in Analytical Work and Heat Treatment of Steels essential.—Address, stating experience, age and salary required, 2493, The Engineer Office. 2493 A

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For continuation of Small Advertisements see page 3

The Gas Turbine in Theory and Practice.

No. III.*

Of the many various types of gas turbine which have been constructed, the majority were designed to work on the constant-pressure cycle; but of those for which any detailed information has been published, three out of the seven were explosion turbines working on a constant-volume cycle, one was an exhaust turbine, and the remaining three, while operating on the constant-pressure super-atmospheric cycle, were all mixed fluid turbines. That is, besides the air and the fuel, steam or water injection was used to reduce the temperature of the mixture. Two of these C.P.M.F. turbines were also tested with air only. No published results are available beyond these air tests for a pure C.P. single-fluid machine, nor for any gas turbine working on a sub-atmospheric cycle, though the latter would probably give results very much superior to any other type. Before going any further into the question, it is necessary to explore the possible efficiencies obtainable when operating the turbine form of engine on an internal combustion cycle, and the C.P. method will be investigated first.

In all heat engines, the continuous output of work is effected by some form of mechanism which utilises the pressure difference in a working substance created by the heat energy supplied. During certain phases of the cycle, heat will flow in; during others it will flow out, and any cycle of operations which the working fluid undergoes can be represented by a closed curve on the P.V. diagram, allowance, of course, being made in those cases in which the same substance is not used continually. The net difference between the heat flowing in and the heat flowing out in a closed cycle is equal to the work done in the cycle, and the ratio of this to the total heat supplied is called the absolute thermal efficiency of the cycle. By this is meant the efficiency which would be obtained were the cycle carried out with no avoidable loss, *i.e.*, without friction, radiation or conduction losses. Both the mechanism and the method of heat supply are thus considered to be perfect. It is assumed that all the heat energy supplied is given to the working substance, and that all the available energy of expansion is converted into useful work, and that the only losses which occur, are those which are inevitable, and which are dependent on the particular cycle, as well as on the working substance. The absolute thermal efficiency thus defined is the maximum attainable with any particular heat cycle. In practice, owing to the occurrence of unavoidable thermal and mechanical losses, these absolute values are impossible to obtain, only about 70 to 80 per cent. can be realised even in the most efficient form of prime mover.

Heat cycles are divided into the two broad subdivisions of external and internal combustion cycles, the latter being distinguished by the fact that the heat addition is due to chemical changes taking place inside the working substance. This condition is again conveniently subdivided into two classes, depending on whether the heat addition takes place at constant pressure or at constant volume, though in practice neither method of supply is found in its pure form. The latter cycle is characterised by the fact that maximum pressure and maximum temperature almost always coincide exactly, whereas even in the large Diesel engine a small portion of the charge burns at constant volume and the balance, about 90 per cent. usually, burns under conditions of constant pressure. These phenomena are very clearly shown in Fig. 1. The indicator diagram is one taken from a large four-cycle Burmeister and Wain engine, and it will be seen that although the maximum pressure is about 530 lb. abs., the maximum temperature is maintained until 20 per cent. of the cylinder volume has been swept, the temperature not commencing to fall until the pressure has dropped to 430 lb. abs. In the upper right-hand corner is reproduced one of the indicator diagrams from the Holzwarth 500 horse-power oil-combustion turbine obtained in May, 1921. The sudden rise and fall of pressure and the sharp corners on the diagram as the valves open and close, are very noticeable.

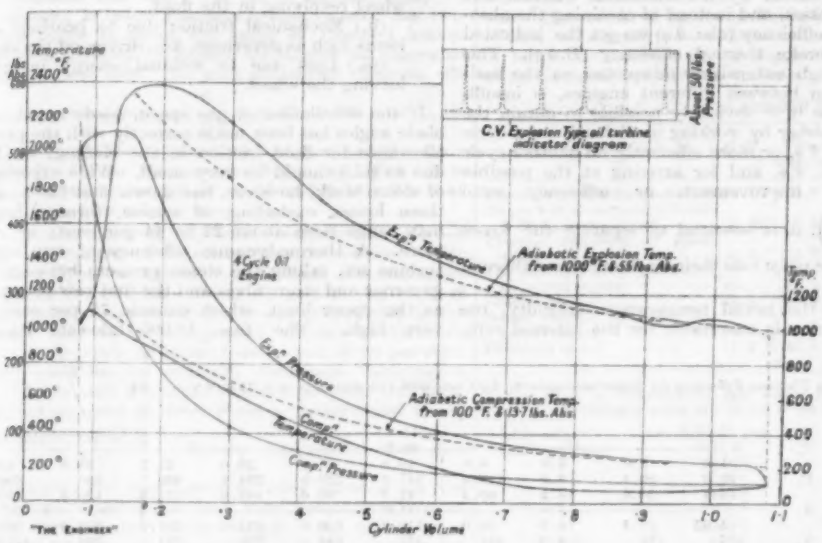

FIG. 1

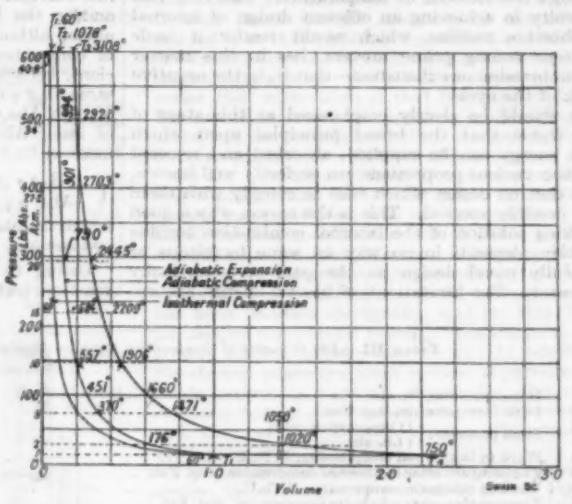

FIG. 2

Whichever cycle is adopted, however, the internal combustion turbine, as is the case in all practical heat engines, consists of the following essential parts:—

(1) A furnace or combustion chamber in which heat is supplied to the working fluid.

(2) A heat sump or cooler into which the working fluid expands after leaving the combustion chamber.

(3) Between these, a mechanism which will absorb the available energy of expansion in the fluid as it flows from 1 to 2, and reproduce it in the form of positive work, and

(4) A mechanism which may either

(*a*) supply the working fluid to the combustion chamber, or

(*b*) withdraw it from the cooler, or

(*c*) combine both functions.

The work for these may be supplied either by the excess positive work or by other means, but in any case forms the negative work of the cycle. Owing to the fact that for the heat flow from furnace to cooler—which in the case of internal combustion engines using non-condensable gases must eventually be the atmosphere—and because this rejection usually takes place at a pressure somewhat greater than that

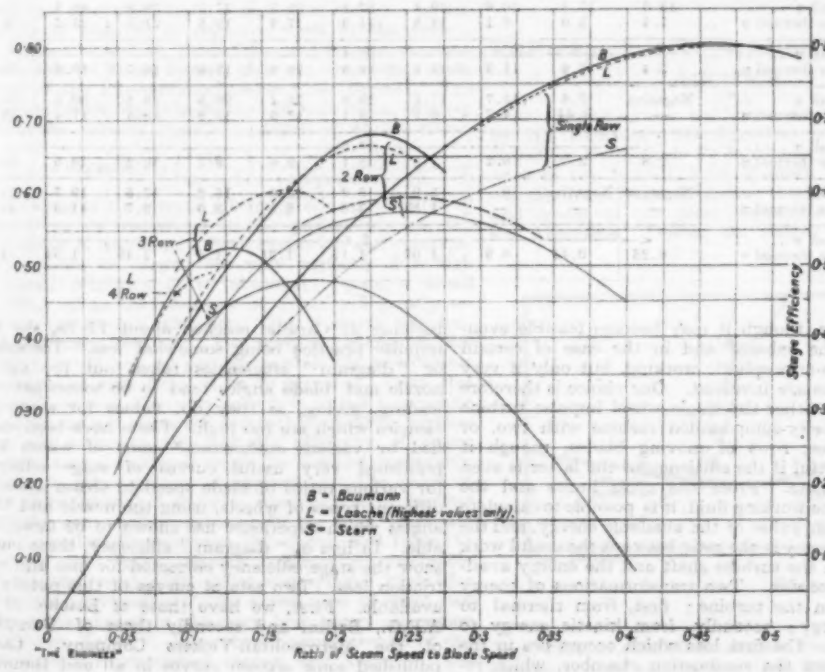

FIG. 3

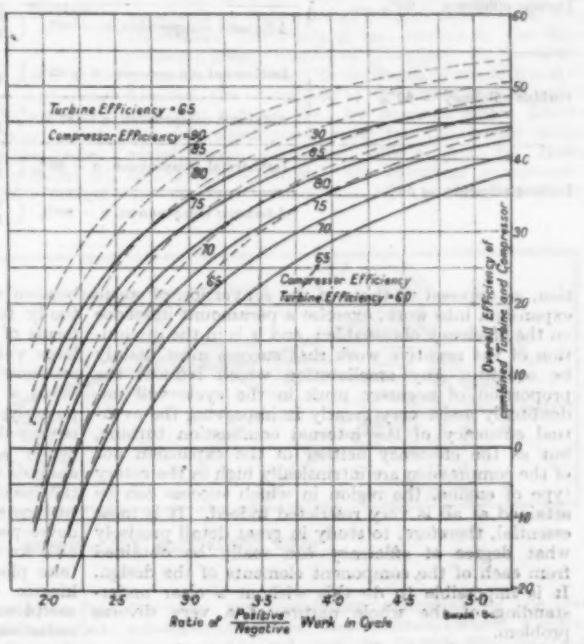
Turbine Efficiency = 65
Compressor Efficiency = 90
Compressor Efficiency
Turbine Efficiency = 60
Overall Efficiency of combined Turbine and Compressor
Ratio of Positive / Negative Work in Cycle

FIG. 4

* No. II. appeared May 11th.

of the atmosphere, in the constant-pressure cycle air must be supplied to the furnace under pressure, whereas the C.V. cycle can, if necessary, be worked without pre-compression, although a certain small amount is advisable in practice. In lieu, however, of using a purely super-atmospheric cycle, either an entirely sub-atmospheric cycle can be adopted, an exhauster taking the place of the compressor, or a combination of the two may be adopted. As was shown in Table I. (*ante*), pre-compression has hitherto always been adopted, the sub-atmospheric cycle not having been employed, and with the exception of Holzwarth, who uses a very small degree of exhaustion, the exhaust pressure has hitherto been above atmosphere. It was stated above—Part I.—that the constructional difficulties all arose through the element of temperature. The very real difficulty in achieving an efficient design of internal combustion turbine, which would render it *facile princeps* among prime movers, lies in this matter of compression or exhaustion—that is, in the negative work of the cycle.

It should be clearly emphasised at this stage of our thesis that the broad principles upon which heat energy can be supplied, absorbed and rejected in their various proportions are perfectly well known, and that no design which fails to comply with them can possibly succeed. This is the reason why a good working solution of the internal combustion turbine problem depends in no way on some fortuitous or radically novel design on the part of some lucky inventor. The limitations of kinetic energy absorption, as opposed to those of the conversion of static expansion, into work, exercise a paramount influence on the efficiency obtainable; and it is in the diminution of the negative work that success must mainly be sought. Any amelioration which reduces the proportion of negative work in the cycle will undoubtedly assist very greatly in improving the eventual efficiency of the internal combustion turbine, but as the efficiency neither of the expansion nor of the compression are intrinsically high in the rotary type of engine, the region in which success can be attained at all is very restricted indeed. It is most essential, therefore, to study in great detail precisely what degree of efficiency can really be obtained from each of the component elements of the design. It is impossible to do this without a clear understanding of the whole nature of a very diverse problem.

The complete cycle of operations is dominated by four factors; from these the absolute thermal efficiency of the cycle can be calculated:

(1) The nature of the fuel to be used.
(2) The method and degree of compression.
(3) The method and amount of heat addition.
(4) The extent of the expansion.

Taking first the case of the C.P. super-atmospheric cycle, it is necessary to use some arbitrary method of comparison, and for this purpose an air cycle is chosen in which use is made of a constant value of specific heat = 0.24, and a constant index of compression and expansion = 1.41. We shall show later how practical considerations modify the figures obtained in this manner, and in nearly all cases it will be found to be to the detriment of the absolute thermal efficiency; hence, these results show the maximum values obtainable. Fig. 2 shows the shape of the P.V. diagram, and Table III. the influence of compression ratio with the different methods and degrees of compression over a range which covers the lowest C.P. gas turbine up to the highest Diesel practice, assuming in all cases a constant temperature of rejection of 750 deg. Fah. If compression and expansion were both conducted with ideal efficiency, and if there were no radiation friction, or other losses to be considered, lines 17 and 18 would represent the thermodynamic efficiency; but in the practical engine—reciprocating or turbine—these values are modified to a very considerable extent by the inevitable thermal and mechanical losses, and instead of attaining the absolute thermal efficiency (abs. $\theta\,\eta$) we get the indicated and/or the brake thermal efficiency (B. $\theta\,\eta$). This alone, although extensively misquoted as the basis of comparison between different engines, is insufficient, because it is obviously possible to obtain the same B. $\theta\,\eta$ either by working inefficiently on a cycle of high Abs. $\theta\,\eta$, or more efficiently on another cycle of lesser Abs. $\theta\,\eta$, and for arriving at the possible measure of improvement, or efficiency ratio $\left(=\frac{\text{B. }\theta\,\eta}{\text{Abs. }\theta\,\eta}\right)$, it is essential to separate the losses which do take place into their mechanical and thermal proportions.

Owing to the initial temperature difficulty, the reaction turbine is unsuitable for the internal combustion cycle, though it may become feasible eventually for the exhaust and in the case of certain forms of sub-atmospheric working, but only if very large volumes are involved. Our choice is therefore restricted to either the single wheel impulse turbine or to a velocity-compounded turbine with two, or possibly three, rows of moving blades, though it is very doubtful if the efficiency of the latter is even nearly adequate. From the cycle limits and the analysis of the working fluid, it is possible to calculate the maximum value of the available energy, and the turbine efficiency is the ratio between the useful work developed in the turbine shaft and the energy available for expansion. Two transformations of energy take place in the turbine; first, from thermal to kinetic energy; secondly, from kinetic energy to useful work. The first loss which occurs lies in the radiation from the combustion chamber, which reduces the amount of energy available for conversion into kinetic work; the second consists in the friction and eddy losses in the nozzle. It is not easy to give a figure for the former. An oil-fired boiler with very large furnace pressed to a high combustion rate may only lose about 5 to 7 per cent. altogether in radiation, provided that it is of efficient and well-lagged design. Very special attention requires to be paid to this feature in gas turbine design, as the whole system is under the suspicion of not possessing sufficient efficiency, and there is absolutely nothing whatever to throw away. The loss in the nozzles is also somewhat problematical. Even in the case of steam, precise data on the best shape is still lacking, but a wide range of experience leads one to believe that, depending very largely on excellence of design and workmanship, the loss may run from about 4 to 8 per cent.; 10 per cent. loss would be a very poor result. The nozzle efficiency reduces the B.Th.U. available for conversion into kinetic energy, and the exit gas speed is then equal to $223.7\sqrt{\text{B.Th.U.} \times \text{nozzle efficiency}}$. There are no data on the performance of high temperature gases in nozzles, and the best plan temporarily is to follow one's judgment based on high temperature steam work. In the case of the second transformation, the conversion of kinetic energy into useful work entails three different losses:

(i.) Friction losses due to (*a*) the fluid passing through the blades, and (*b*) the friction of the wheel revolving in the fluid.
(ii.) Mechanical friction due to bearings and items such as governors, &c., driven off the shaft.
(iii.) Loss due to residual energy in gases leaving the wheel.

If the calculation of gas speed, blade speed, and blade angles has been made correctly with the proper allowance for fluid friction in the blading, the loss due to (iii.) should be very small. Wide experience of steam work, however, has shown that the sum of these losses, excluding, of course, furnace losses, may range from about 22 to 44 per cent., or even more. A thermodynamic efficiency of any steam turbine set, taking the steam pressure between the governor and stop valves and the first row of nozzles as the upper limit, which exceeds 75 per cent., is very high. The five 10,000 kilowatt Parsons turbines at Carville reached about 77–78, the best impulse practice being somewhat less. Theoretical or "diagram" efficiencies taken out for various nozzle and blade angles tend to be somewhat misleading, giving, as they do, values for stage efficiencies which are too high. These have been modified by various authorities,* some of whom have published very useful curves of stage efficiency for various ratios of blade speed to steam speed for different types of wheels, using the nozzle and blade angles which experience has shown to be most suitable. In lieu of "diagram" efficiency, these curves show the stage efficiency corrected for disc and vane friction loss. Two sets of curves of this nature are available. First, we have those of Lasche, of the A.E.G., Berlin, and secondly those of Baumann, of the Metropolitan-Vickers Company. Lasche published some sixteen curves in all and Baumann six, and from this Fig. 3 is compiled. For the single-row wheel, the two curves are almost identical when Lasche's highest values are taken. For the two-row wheel, there is again very little to choose between the two, but for the three-row wheel it will be noticed that there is a marked difference, Baumann's losses being apparently very much higher than Lasche's. Even if the latter's best value of 0.605 efficiency at $\frac{V\,t}{V\,s} = 0.17$ be accepted, the figure is unsuitably low for gas turbine work, and leaves us really with no choice except that of the two-row wheel. For

* Reference should be made to Dr. W. J. Goudie's excellent book on "The Steam Turbine," pp. 326 *et seq.*, for further details as to these curves.

Table III.—*The Influence of Compression Ratio on Absolute Thermal Efficiency for Super-atmospheric Air Cycle with Constant* C *p* = 0.24 *and* γ = 1.41.

1	Initial pressure, lb. abs.	P_0	<—				14.7					—>
2	Initial temperature, deg. Fah.	T_1	<—				60.0					—>
3	Final pressure: Compression ratio		1.5	2.0	5.0	6.8	10.0	15.0	20.0	27.2	34.0	40.8
	Final pressure: Lb. abs.	P_1	22.0	29.4	73.5	100.0	147.0	220.0	294.0	400	500	600
4	Work in isothermal compression, B.Th.U.		14.4	24.6	57.2	68.5	81.7	96.0	107.0	117.3	125.3	132.0
5	Temperature after isothermal compression, deg. Fah.	T_1	<—				60.0					—>
6	Work in adiabatic compression, B.Th.U.		15.65	27.8	74.5	94.0	119.2	150.0	175.0	202.0	224.0	244.0
7	Temperature after adiabatic compression, deg. Fah.	T_2	125	176	370	451	557	684	790	901	994	1078
8	Temperature after adiabatic expansion, deg. Fah.	T_4	<—				750					—>
9	Temperature leaving furnace, deg. Fah.	T_3	901	1020	1471	1660	1906	2201	2445	2703	2921	3108
10	Work in adiabatic expansion, B.Th.U.	C *p* (9-8)	36.2	64.8	173	218.5	277	348	407	469	522	566
11	Heat added in furnace (isothermal compression), B.Th.U.	C *p* (9-5)	202	231	339	384	443	515	573	635	688	732
12	Heat added in furnace (adiabatic compression), B.Th.U.	C *p* (9-7)	186	202.5	264	290	323.5	364	397	433	462	487
13	Net work done (isothermal compression), B.Th.U.	10-4	21.8	40.2	115.8	150	195.3	252	300	351.7	396.7	434
14	Net work done (adiabatic compression), B.Th.U.	10-6	20.55	37.0	98.5	124.5	157.8	198	232	267	298	322
15	Ratio $\frac{\text{positive}}{\text{negative}}$ work (isothermal compression)	$\frac{10}{4}$	2.51	2.64	3.03	3.19	3.39	3.63	3.81	3.98	4.16	4.3
16	Ratio $\frac{\text{positive}}{\text{negative}}$ work (adiabatic compression)	$\frac{10}{6}$	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
17	Absolute thermal efficiency (isothermal compression)	$\frac{13}{11}$	10.8	17.4	34.2	39.1	44.1	49.0	52.5	55.3	57.6	59.3
18	Absolute thermal efficiency (adiabatic compression)	$\frac{14}{12}$	11.05	18.3	37.3	43.0	48.8	54.5	58.5	61.6	64.5	66.0

Table IV.—*The Influence of the Efficiencies of Turbine and of Compressor on the Possible Brake Thermal Efficiency of the Internal Combustion Turbine Working on Super-atmospheric Cycle as above.*

Turbine efficiency = 65%	Isothermal compression, η = 70%	Overall η	13.2	17.3	26.6	29.4	32.4	35.3	37.2	38.8	40.3	41.5
		Brake thermal η	1.4	3.0	9.1	11.5	14.3	17.3	19.5	21.5	23.2	24.6
	Adiabatic compression, η = 90%	Overall η	<—				30.4					—>
		Brake thermal η	3.4	5.6	11.3	13.1	14.8	16.6	17.8	18.7	19.6	20.0
Turbine efficiency = 60%	Isothermal compression, η = 65%	Overall η	Negative	2.5	13.7	17.1	20.6	24.4	26.5	28.5	30.2	31.5
		Brake thermal η	—	0.44	4.7	6.7	9.1	12.0	13.9	15.8	17.4	18.7
	Adiabatic compression, η = 85%	Overall η	<—				16.6					—>
		Brake thermal η	1.8	3.0	6.2	7.2	8.1	9.0	9.7	10.2	10.5	11.0
Turbine efficiency = 55%	Isothermal compression, η = 60%	Overall η	Negative	Negative	0	3.9	8.2	12.5	15.2	17.5	19.7	21.2
		Brake thermal η	—	—	—	1.53	3.6	6.1	8.0	9.7	11.3	12.5
	Adiabatic compression, η = 80%	Overall η	<—				2.4					—>
		Brake thermal η	0.26	0.44	0.9	1.03	1.17	1.31	1.4	1.48	1.54	1.58

small machines and small heat drops a single row might suffice, but until stages in series are rendered possible by improvements in material this type can only be considered academically. The point to notice is that, within very narrow limits, the respective stage efficiencies do not exceed 0.8 and 0.68. Stern, in his excellent report to the Air Ministry on the subject of the possible use of an internal combustion turbine for aircraft, quotes efficiencies from which the curves marked "S" have been compiled. These, however, include nozzle as well as friction losses, and are thus not quite directly comparable with the others; for the two-row wheel, a correction curve has been added on the assumption that the nozzle loss was 6 per cent. Stern's single-row efficiency is below Lasche's lowest values; his two-row curve is about the same as Lasche's lowest. One is inclined to regard his figures as somewhat on the low side. To give maximum diagram efficiency, the ratio of $\frac{V\,t}{V_s} = 0.47$, 0.235 and 0.156 respectively, are required for one, two and three-row wheels. With the friction losses included, these fall slightly to, say, 0.45, 0.22 and 0.14. We shall return to this subject later.

For the moment, only brief reference will be made to the subject of air-compressor efficiencies. With piston type compressors quite high efficiencies are obtainable, efficiency being defined as the ratio of the work re-appearing in the compressed air to the work done on the compressor. Ratios of indicated air horse-power to brake horse-power of 90 per cent. are common in ordinary two-stage inter-cooled machines, and it is usual practice to quote the brake power required to drive them as being equal to the adiabatic air $\frac{\text{H.P.}}{0.9}$. Rotary compressors show less efficiency, but are obviously more suitable for the purpose, besides the fact that transference losses are not included in the former. An efficiency of 65 to 70 per cent., compared with the isothermal, should, however, be obtained. Much depends on the amount of cooling. Very high actual efficiency of the work of a piston in a cylinder is obtained, the operations of both compression and expansion often exceeding 95 per cent., but the type is not suitable for large powers. The relatively low efficiency of the rotary compressor is a heavy handicap on the C.P. gas turbine.

Assuming that the compressor or exhauster is driven by the surplus positive work of the turbine, the overall efficiency of the two combined, corresponding to the thermodynamic efficiency of an ordinary engine, must be determined. The brake thermal efficiency is the product of the absolute thermal efficiency and the overall efficiency of turbine and compressor combined. This overall efficiency depends not only on the efficiency of the turbine and that of the compressor, but also on the ratio of positive to negative work in the cycle—see lines 15 and 16, Table III.—and it is on the combination of these factors that the successful working of the internal combustion must depend. The overall efficiency is given by the expression, wherein K is the ratio of positive to negative work:—

$$\text{Overall } \eta = \text{expansion } \eta\left(\frac{K}{K-1}\right) - \frac{1}{\text{compression } \eta\,(K-1)}$$

Values of the overall efficiency are extraordinarily sensitive to variations in K, particularly as the value of K decreases. Both expansion and compression must be carried out very perfectly if a high overall efficiency is to obtained; quite a small falling off in the efficiency of either will greatly reduce the overall efficiency. Fig. 4 shows this tendency very clearly. The turbine efficiences are taken as 65 and 60 per cent., while the compressor efficiencies vary from 65 to 90 per cent. From this it will be seen how very easy it is to fail to produce a working self-contained internal combustion turbine at all, although the intrinsic efficiency of either turbine or compressor might be deemed reasonably good in other spheres of application. The value of K must exceed 4.0 for a combination of turbine 65 per cent. and compressor 90 per cent. to obtain an overall efficiency of oven 50 per cent., and Table IV. shows the brake thermal efficiencies obtainable with the pure C.P. super-atmospheric cycle for various combinations. As a reminder of what can be accomplished in the very best heavy oil engine practice, Table V. gives the efficiency results of the Scott-Still experimental engine, and Table VI. the oil consumptions corresponding to various brake thermal efficiencies. The relatively high exhaust temperatures which have been used in certain four-cycle engines do, of course, adversely affect both the K values and the absolute thermal efficiencies. The extent of this, assuming an exhaust T_4 deg. Fah. of 1050 deg.—see Fig. 2—is not very serious until low compression ratios occur, and is shown in Table VII., and as expansion and compression operations are very efficiently performed, the influence on brake thermal efficiency is not very great. Messrs. Scott, with an absolute thermal efficiency of 50 per cent., obtained a brake efficiency of 35.0. Table VII. shows that K must have been in the neighbourhood of 3.0. The overall efficiency of $\frac{35}{50} = .70$ for such a value means that from the above formula the efficiencies of expansion and compression were approaching 0.90. In point of fact it was 85.9. Fig. 4 shows for this K value an overall efficiency of 0.42, with turbine 65.0 and compressor 90, and 0.39 with the latter equal to 85.9 per cent., against the 70 per cent. of the Still engine. These figures show very clearly what advances in turbine and rotary compressor efficiency are necessary before the internal combustion turbine can hope to approach the low consumption of the oil engine. There is no suggestion made here that it will do so. It is a very good steam plant that can obtain a shaft horse-power for 14,400 B.Th.U., or 0.8 lb. of oil per hour, the brake thermal efficiency then being 17.7 per cent. A number of figures in Table IV. are in excess of this value, and this without including a number of refinements which go to augment the efficiency of the internal combustion turbine.

TABLE V.—*Trials of Scott-Still Engine.*

Proportion of load.	Half.	Three-quarter.	Full load.	Over-load.
Effective shaft horse-power ..	159.1	236.9	327.3	367.2
Oil per S.H.P. per hour (18,053 B.Th.U. lower value) ..	0.383	0.384	0.387	0.401
Thermal efficiency of ideal engine	51.6	55.0	50.8	50.0
Thermal efficiency indicated by actual engine	44.1	42.5	39.2	38.4
Efficiency ratio	85.4	83.3	77.2	76.8
Brake thermal efficiency of actual engine	36.8	36.7	36.4	35.2
Efficiency ratio	71.3	66.8	69.7	70.4

TABLE VI.—*Oil Consumption and Brake Thermal Efficiency.* Lower calorific value of 1 lb. oil = 18,000 B.Th.U.

Lb. oil per B.H.P. per hour.	B.Th.U. per B.H.P.	Brake thermal efficiency.
1.0	18,000	14.13
0.9	16,200	15.7
0.8	14,400	17.7
0.7	12,600	20.2
0.6	10,800	23.55
0.5	9,000	28.26
0.4	7,200	35.4
0.3	5,400	47.2
0.2	3,600	70.8
0.1413	2,546	100.0

TABLE VII.—*The Influence on* K *and Abs.* $\theta\,\eta$ *of Terminating Expansion at* 1050 *deg. Fah. as in Four-cycle Piston Engine.*

Initial pressure, lb. abs.	100	147	220	294	400	500	600
Line 10 ..	146.5	205	276	335	397	450	494
Line 13 ..	78	123.3	180	226	279.7	324.7	362
Line 14 ..	52.5	85.8	126	160	195	226	250
Line 15 ..	2.14	2.51	2.88	3.13	3.39	3.59	3.74
Line 16 ..	1.55	1.72	1.84	1.91	1.97	2.01	2.03
Line 17 ..	20.3	27.9	35.0	39.8	44.0	47.2	49.5
Line 18 ..	18.1	26.6	34.6	40.4	45.0	49.0	51.4

Railway Electrification in South America.

AN electric service was inaugurated on April 30th by His Excellency the President of the Argentine Republic, Dr. Marcelo T. de Alvear, on the suburban lines of the Buenos Aires Western Railway, which extends from Buenos Aires to the foot of the Andes, and is one of the great British-owned systems in the Argentine. During the twelve months ending June, 1922, 11,000,000 passengers were carried on the western system, and no fewer than 9,000,000 travelled on the section serving the suburbs of Buenos Aires. The goods traffic consists mainly of wheat, maize, and general merchandise. Four great British-owned railways, which have their headquarters in Buenos Aires, serve different sections of the suburbs. The Central Argentine Railway, which covers the northern districts as far as Tigre River, commenced an electric service on the Tigre lines in the year 1916.

The Buenos Aires and Pacific Railway runs through Palomar and Hurlingham; the Buenos Aires Western Railway extends due west through Liniers, Moron and Moreno, and the Buenos Aires Great Southern Railway serves the suburbs out towards La Plata and Burzaco. The termini of these railways are all some distance from the centre of the city, and are linked up by a comprehensive tramway system. Urban traffic is also catered for by the Subterraneo of the Anglo-Argentine tramways—an underground system which extends from the Government House to Plaza Once, and onwards to Flores on the Buenos Aires Western Railway. It was in order to facilitate transhipment of passengers that the railway arranged with the Anglo-Argentine Company to establish a joint underground station beneath Plaza Once, near its main terminal station Once, and to run its suburban trains from that station.

On May 1st, 1923, the company commenced this service in combination with the trains of the Anglo-Argentine Subterraneo, and through tickets are now issued from the suburbs on the Western line to any station on the Subterraneo between Once and Plaza de Mayo. This scheme of inter-communication turned the attention of the railway company's London Board to the question of electrification, and led it in 1912 to obtain from Merz and McLellan, of Westminster, a report upon the electrification of the suburban line. Work was commenced in 1913 under the supervision of that firm, and of Livesey, Son and Henderson, the company's consulting engineers, but the outbreak of the war caused the work to be suspended for a number of years.

On the conclusion of hostilities, however, progress was resumed, and on October 16th, 1922, the first electric passenger train was run between Once (High Level) Station and Castelar, which is the end of the second zone of the Western suburban line—see map, Fig. 1. Since that date, as rolling stock became available, more and more of the suburban traffic has been handled electrically, and on May 1st the full service commenced running from the joint underground station below Plaza Once. In addition to the electric passenger train service, a portion of the goods service is handled electrically, the railway company having constructed a tunnel between Once and the port of Buenos Aires. This tunnel is 5.1 kiloms. long.

The complete electrification works for the suburban system include a power station of 25,000 kilowatts capacity—see Figs. 2 and 3, and Figs. 7, 8, 9 and 10 on page 526—72.5 miles of high-tension cables, four traction sub-stations with 15,000 kilowatts of converting plant, and the electrical equipment of 70 miles of single track. In addition the supply of power and lighting calls for transforming plant to the extent of 7000 kilowatts, this being distributed over the system in four static sub-stations and two of the traction sub-stations.

Power is produced in the generating station in the form of three-phase current at 20,000 volts, with a periodicity of 25 cycles. It is transmitted to sub-stations, converted to direct current at 800 volts, and supplied to the electric trains through a third rail. At the port and in goods sidings to be electrified in the future, overhead electrical equipment has been installed.

The whole of the equipment employed in connection with the electrification scheme was manufactured in Great Britain. The boiler-house and its plant were built by Babcock and Wilcox, Limited, the turbo-alternators, transformers and motors by the Metropolitan-Vickers Electrical Company, the condensing plant and pumps by Richardsons, Westgarth and Co., Limited, the switchgear in the power station and the auxiliary motors, &c., by Siemens Bros., Limited, the structural steel work for the power station, switch-house, test-room, offices, &c., by Heenan and Froude, Limited, the electrical equipment of the traction sub-stations by the English Electric Company, the transformer equipment of the static sub-stations by the Metropolitan-Vickers Electrical Company, Limited, and the British Electric Transformer Company, the high-tension and low-tension static sub-station switchgear by A. Reyrolle and Co., Limited, the rolling stock bodies by the Birmingham Carriage and Wagon Company, Limited, the rolling stock underframes and bogies by the Leeds Forge Company, Limited, and the rolling stock electrical equipment by the Metropolitan-Vickers Electrical Company. W. T. Henley's Telegraph Works, Limited, were responsible for the high-tension transmission and the low-tension track cables. The railway company and its staff carried out the foundation work for the power-house, and the company also laid the third rail and erected the overhead equipment in the Port Lands.

The power-house—illustrated in Fig. 2—has been

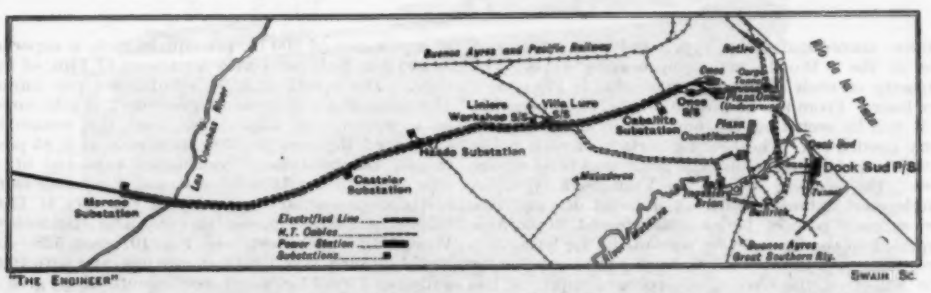

FIG. 1—MAP SHOWING THE ELECTRIFIED LINES

placed near the Riachuelo on the dock side on a site between the latter and the river Plate. It was erected jointly by the Buenos Aires Western and the Buenos Aires Great Southern Railways, and has been designed not only to supply power for the suburban lines of the Western railway, but also to give a supply to the Western workshops at Liniers and the terminal station at Once, and to the Great Southern workshops at Banfield and the terminal station at Constitucion. When the Southern Railway decides to electrify its suburban lines the power station can be extended as required. The boiler-house is at right angles to the engine-room, whilst the main transformer house and switch house are parallel to it, this design being adopted with the view of making the power-house ultimately contain twelve turbo-generator sets and four boiler-houses. Suitable coaling facilities are also provided with the usual coal and ash handling plant. At the permanent end of the engine-room a loading bay, fitting shop, stores and workmen's accommodation have been provided.

The boiler-house contains seven Babcock and Wilcox marine type boilers, with a normal evaporation of 20,000 lb. of water per hour, and working at a pressure of 210 lb. per square inch and a superheat of 600 deg. F. They are fitted with the makers' oil fuel equipment. The boilers are grouped in pairs, and each boiler has its own superheater and economiser. Each of the Green's economisers contains 200 pipes. The boiler equipment also comprises ten "Sirocco" fans, seven "W R" CO_2 indicators and four feed pumps, two being of the impulse turbine-driven centrifugal Weir type, and the other two are of the "Woodeson" reciprocating type. The capacity of each of the rotary pumps is 175,000 lb. per hour. From the illustration—Fig. 9, on page 526—it will be seen that the pump-room is laid out on very good lines. The heating surface of each boiler is 4170 square feet, whilst the grate area is 98 square feet. The stokers are of the Underfeed type. A single steel chimney, with an induced draught fan, serves each pair of boilers, and forced draught is supplied to the furnaces by six fans in the basement. Originally it was intended to burn coal, but recently the whole of the Underfeed stoker equipment has been replaced by Babcock oil-firing equipment. With the introduction of oil firing the ash and coal-handling plant was, of course, put out of commission, but it has been retained, and can be put into operation at short notice if occasion should arise. For the storage of oil two storage tanks have been erected adjacent to the power-house. Each of those tanks has a capacity of 100 tons, and they draw their supply from the main oil deposit tanks of the Buenos Aires Western Railway Company, these tanks having a capacity of 8000 tons.

The generating plant is arranged on the "unit" system, and it is possible to start up any one of the turbo-alternators, and this gives a supply to the main bus-bars and to all station auxiliaries. Further, the breakdown of anything comprised in one generating unit will not affect the operation of other sets. As shown in Fig. 7 on page 526 there are three turbines in the engine-room, although foundations are provided for the installation of a fourth set when necessary. Each turbine set has its own steam-driven oil pump for use when starting up and shutting down, also its own condenser, with air and water extraction pumps and an independent circulating water pump. A self-excited exciter is coupled direct to the alternator shaft, and from the alternator, leads are run direct to the "unit" transformer, which steps down the generated voltage from 2500 to 440, giving a supply to the unit distribution board.

From this board all units belonging to the generating set to which it belongs can be operated, whilst, alternatively, a supply can be obtained from the station distribution boards, these being provided for the power to the station auxiliaries common to the whole station, *i.e.*, high and low lift pumps, economisers and fan motors. The main leads of the alternator run to three single-phase transformers which step up the generated voltage to 20,000, at which pressure the power is supplied to the station bus-bars.

Immediately above the station distribution chambers are two chambers which contain the two motor generators used for lighting the station and for charging the two batteries provided for the power required by the operating magnets of the main oil switches. They also provide the power for the tripping coils of switches and the indicating lamps on the switchboard.

The main bus-bars are in duplicate and the switchgear is arranged so that any generator, feeder, &c., can be put on either bus-bar as desired. Interconnection and subsection of the bus-bars is also possible.

The Metropolitan-Vickers turbines are of the Rateau horizontal type, and are designed to work at a pressure of 200 lb. per square inch, a superheat of 600 deg. Fah., and with a vacuum of 1½in. of mercury. The speed is 1500 revolutions per minute. The three-phase alternators generate 25-cycle current at a pressure of 2500 volts, and the economical output of the sets is 6200 kilowatts at 0.85 power factor, the maximum continuous capacity of the alternators being 7500 kilowatts at 0.8 power factor, and the momentary capacity of the sets is 11,000 kilowatts at 0.85 power factor. The Richardsons-Westgarth condensers—see Fig. 10, page 526—have a cooling surface of 13,500 square feet, and with 10,000 gallons of cooling water per minute they give an absolute pressure of 2.1in. of mercury when dealing with 90,000 lb. of steam per hour with the cooling water at a temperature of 80 deg. Fah.

All the main switching is done at a pressure of 20,000 volts, and the main switchgear is placed in a separate building The control room from which the whole of the high-tension switching is done on the remote control system, and which was built by Siemens, is shown in Fig. 3. Emergency panels for each machine are also fitted in the engine-room, so that in the case of emergency the turbine driver can, by pressing a button, open the main switches of the machine. The high-tension transmission system consists of 20,000 volt split-conductor underground feeders. There is also a complete system of telephone cables. The protective gear used on the high-pressure apparatus in the power station and on the outside system, is of the Merz-Price and Merz-Hunter type.

As at present electrified the line is served by four traction sub-stations situated at Once, Villa Luro, Castelar and Moreno. The buildings are all of the same general design, being steel-framed structures walled with brick and covered with cement plaster. The floors and roofs are concrete reinforced with Clinton fabric, the roofs being covered with a Paroid waterproof. Provision is made near each sub-station for housing the attendants. Each building is divided into three main aisles, the centre one containing the rotary converters and the side ones the transformers, and remote from them the high-tension and the direct-current switchgear. There is a loading bay at one end, into which a siding runs so that railway trucks can be brought under the overhead crane which traverses the whole building.

In the sub-station at Once, and in that at Villa Luro, there are three rotary converters, whilst in the sub-station at Castelar and in that at Moreno, there are in each case two converters. All these machines, which were built by the English Electric Company, are compound wound, fitted with commutating poles and are diametrically connected. The normal rating of each machine is 1000 kilowatts at 800 volts, but the machines are capable of giving 15,000 kilowatts for two hours, 2000 kilowatts for ten minutes, and 3000 kilowatts momentarily. Two of the sub-stations include plant for the supply of power and lighting for general purposes. At Villa Luro frequency changes are installed, as shown in Fig. 8, on page 526, to change the 25-cycle current to 50-cycle current for use in the workshops.

The electrical equipment of the track comprised the bonding of the track rails, the erection, bonding and protection of the conductor rails, the laying of inter-connecting cables across gaps in the conductor rail and the provision of switchgear for dividing up the track into short electrical sections. In the case of the Port Lands, it also comprised the erection of structures and overhead equipment.

The conductor rail, which was supplied by the North-Eastern Steel Company, and H. J. Skelton and Co., Limited, weighs 86 lb. per yard, and its electrical resistance is 6.7 times that of copper of equal volume. A view of the conductor rail, with its protection, is shown in Fig. 4. The rail is rolled in high conductivity steel, and was dipped hot in bitumastic solution before shipment to prevent rusting. Single fish-plates are applied to the back of the rail, the bolt head being countersunk in the web to leave a free passage for the toe of the skate. Two bonds with solid plug heads are fixed under the fish-plate, giving a cross-section of .33 square inch of copper at each joint.

Where gaps occur the rails finish off with cast steel ramps 5ft. long, shaped to guide the skate into position without jarring. The rails and ramps are covered with a protection of lapacho wood boards built up in the shops and fixed in position on the site by hook bolts, which embrace the edges of the top table and foot of the rail. The rail is carried on malleable iron castings cemented into porcelain insulators, which stand on the ends of specially long sleepers, and are fixed to them by malleable iron clips. The sleepers are of Argentine hardwood, called "Quebracho." In order to allow for the wear of the rails into the sleepers, and also the wear of the running rails, the insulators are placed on packing pieces of soft wood and felt, these being removed as required. To prevent creepage every length of conductor rail is anchored, three types of anchors being used.

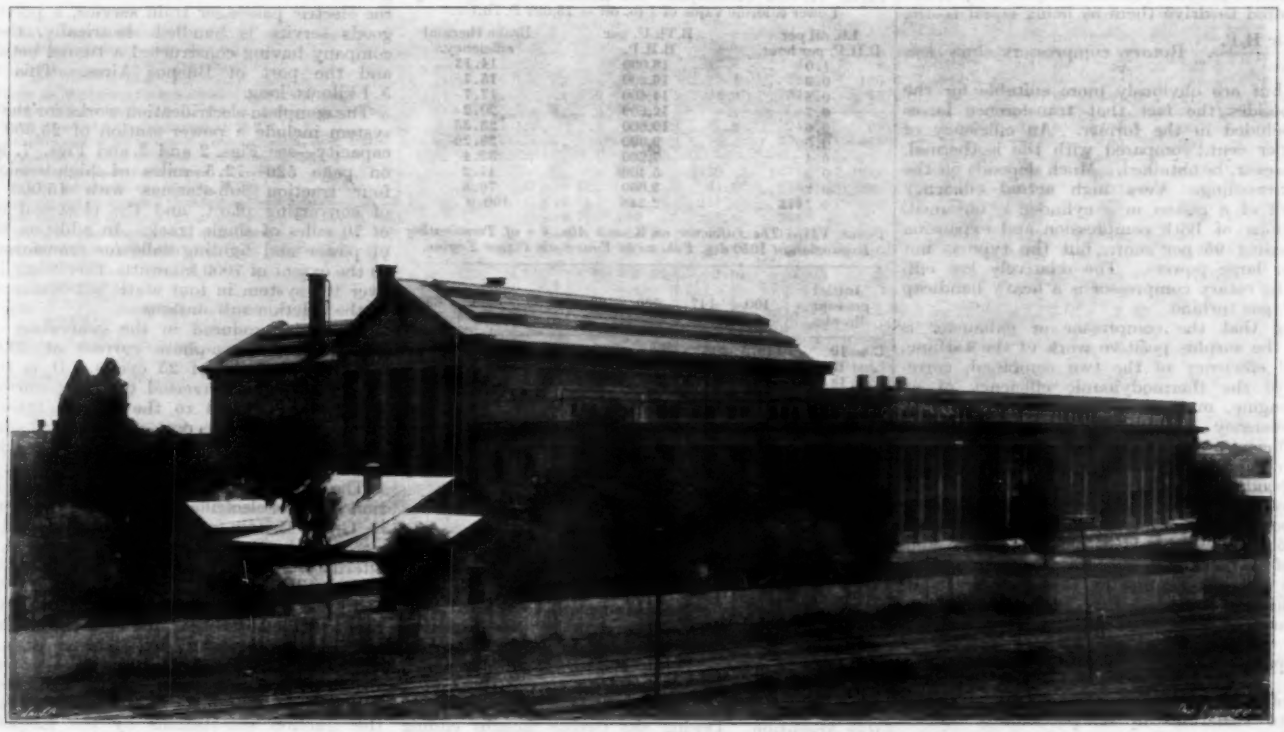

FIG. 2—THE POWER HOUSE

At all road crossings and special track work continuity of conductor rails is provided by the installation of 1 square inch track cables. These cables are carried in Key's fibre conduit enclosed in iron troughs and filled with pitch. All positive cables finish in terminal pillars consisting of cast iron bends, into which a fibre bend is slipped, the cable being threaded through and the core sweated into a gun-metal cap resting on a porcelain insulator fitted into the top of the bend. The cap has bolted to it a terminal plate with sockets for stranded bonds which make connection with the conductor rail. The cap and terminal are surrounded by a potware or telenduron cover, which prevents accidental contact with live metal by passers-by. Similar arrangements are made at places where it is necessary to cut the rail to leave room for expansion, say, ¼ mile from an anchor.

FIG. 3—THE CONTROL ROOM

The conductor rail is divided into sections by switches mounted in signal cabins and so arranged that the signalman can quickly isolate any faulty section, leaving the rest of the system unaffected.

Paralleling of the "up" and "down" conductor rails is also provided for in order to make use of their combined conductivity. The switchgear is of the circuit breaker type, and is automatic or non-automatic, according to position.

All the switchgear is mounted in chambers separate from the signal cabin operating chamber, and controlled by levers of the signal cabin type. Emergency switches, mounted in cast iron boxes adjacent to the tracks, are provided at cross-overs.

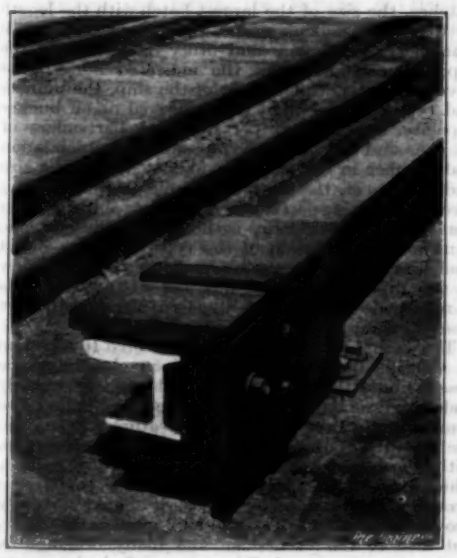

FIG. 4—THE CONDUCTOR RAIL

The tracks in the port section of the system are equipped with an overhead construction, which was erected under the supervision of the railway company's engineers. A general type of catenary construction adopted is shown in Fig. 5. The overhead contact wire consists of a single hard drawn copper conductor of 0.166 square inch section, the wire being supported by a stranded copper catenary wire of 0.20 square inch section, from which it is suspended by means of copper wire droppers. The main copper catenary wire is supported from the steel structures by means of special insulators, double insulation being used throughout. The normal span between the steel structures is 80 yards, whilst the normal height of the contact wire from rail level is 19ft. 8in., but at the entrance to the goods tunnel this is reduced to 15ft. 9in. Each steel structure carries a steadying arm, for the purpose of fixing the position of the contact wire relatively to the track, but at cross-overs and certain other places special pull-off wires with lapacho distance pieces are required. The contact wire is staggered in the usual way to prevent undue wear of the bow collectors. The type of steel structure varies according to conditions, the cantilever type being used on approach tracks to sidings, whilst in the sidings, bridge structures with cantilever construction for outside tracks are used. The majority of the masts are made up of angle irons suitably braced, but there is also a number of masts made up of old track rails braced together. All the structures are bonded to the running rails by means of a hard copper bond of No. 0.08 square inch section.

The passenger rolling stock is arranged for multiple unit working. There are twenty-five first-class motor coaches, twenty-one second-class motor coaches, twenty-five first-class trailer coaches, twenty second-class trailer coaches, and one composite motor coach, the latter being used on the spur line between Villa Luro and Versailles. The length of this line is 2.8 kiloms., and as the service is infrequent, a single coach meets the requirements. When it is out of service for repair or overhaul it is replaced by one of the first-class motor coaches. All the coaches are of the saloon type with cross seats, and are fitted with vacuum brakes.

The collector shoes are designed to make contact on the underside of the top flange of the channel section conductor rail. They have two sets of springs—one a coil spring holding the skate in contact with the running face of the conductor rail, and the other a laminated spring pressing the lower portion of the shoe outwards from the coach, and allowing for lateral movement of the shoes with respect to the conductor rail. In all a total lateral movement of 5¼in. can take place between the shoe and the rail without the skate disengaging from the rail or binding so solidly on the web as to cause breakage. The total end movements expected are much less than this. Each motor bogie has collector shoes on each side, and one bogie of each trailer coach. A main bus cable and a 10-point control cable run through the length of the train connected between coaches by removable flexible jumper cables. All shoes are connected to the main bus line through copper strip fuses mounted in insulating boxes fixed to the shoe beam over the collector shoe. Similar fuses are connected in the bus line at each end of each coach to facilitate the automatic isolation of faults on the bus line connections.

FIG. 5—OVERHEAD CONSTRUCTION

The motor coaches have two motor bogies, each fitted with two motors. The nominal one hour rating of each of these motors is 220 horse-power and the working pressure is the same as that on the line, viz., 800 volts. With a four-coach train containing two motors and two trailers an average acceleration on level tangent of 1.25 miles per hour per second up to 22 miles per hour is obtained with an average accelerating current of 290 ampères per motor. With a six-coach train containing two motor coaches and four trailers an average acceleration on level tangent of 0.8 miles per hour per second is obtained with a current per motor of about 270 ampères. The motors, which have solid box frames, are four-pole machines and are provided with commutating coils. All the control equipment except that for motor and auxiliary control is mounted underneath the coach. The contactors and reversers are in cases fitted with dust-proof covers. The circuit breakers blow the arc out into the open air, the closing and tripping coils being energised from any cab. The acceleration is automatic, each motor coach being fitted with a controlling relay containing a series coil and two control coils. The

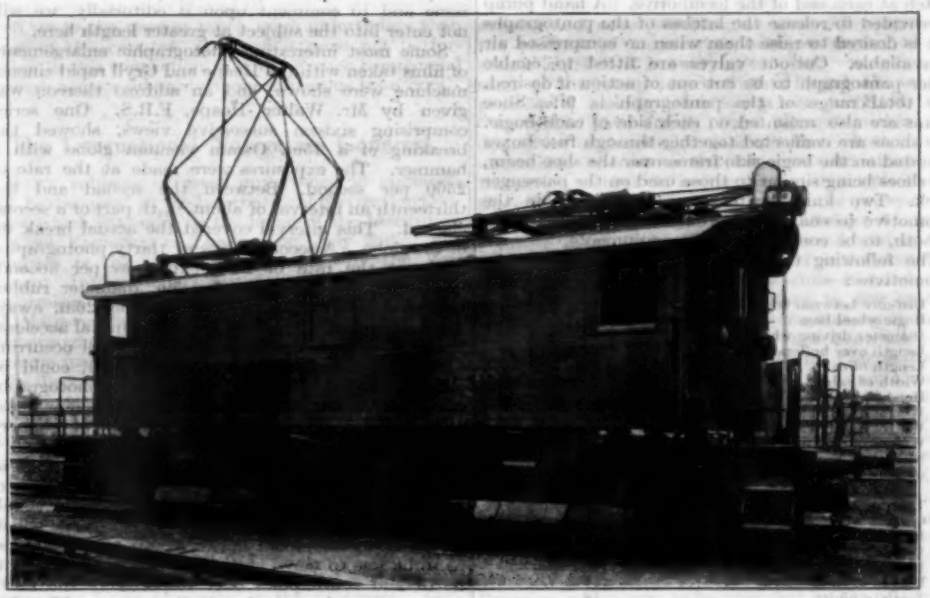

FIG. 6—BUENOS AIRES WESTERN RAILWAY—ELECTRIC GOODS LOCOMOTIVE

feed to the control circuits in the various steps is made alternately through the two relay control coils, and the latter when energised, lift plungers and contacts in circuit with the control for the succeeding step. Once a plunger is lifted it is retained by the current in the main coil if above the value for which the relay is set. This main coil carries the current of one motor. The rate of operation, therefore, depends on the current in the motors, and cannot be increased by the driver.

For handling of goods trains to and from the port through the tunnel from Once, two electric locomotives—as shown in Fig. 6—are provided. They are of the 0-4-4-0 type, and consist of two articulated four-wheel bogies carrying the cab on four spring-loaded sliding seats per bogie. The draw-gear and buffers are mounted on the bogie frame. The articulation between the bogies is made through the convex faces of bumpers by means of a solid draw-bar link, having slot holes to engage with vertical hinge pins. Side buffers are also provided to control the angular dispalcements. Each of the four motors is supported from its axle on two suspension bearings and from the bogie centre transom through a laminated spring support.

Each end of the cab contains the necessary driving gear, and the control equipment is carried in the middle. The motors are of the box-frame type, fitted with commutating poles, and a blower is supplied for supplying air to the machines. The equipments are controlled by contactors operated by compressed air through electrically controlled valves. The compressed air supply at 60 lb. pressure is supplied through a reducing valve from the main air system. Two reversers are fitted for the control of direction, and they are operated in the same way as the contactors.

Cut-out switches are provided for cutting out defective motors, one pair at a time. These switches also have a control blade to prevent the equipments being worked up to full parallel if either pair of motors is cut out. The locomotives are fitted with straight air brakes with an emergency pipe. Air is supplied from a compressor with a capacity of 17½ cubic feet of free air per minute at normal temperature and pressure, and is compressed to 90 lb. per square inch. A governor cuts in the compressor motor at a pressure of 70 lb. per square inch and cuts it out at 90 lb. Brake blocks are applied to both sides of all wheels, and the brakes can be operated from either end of the locomotive. Sand can be applied to either side of all the wheels, by means of compressed air controlled from a two-way valve at each driving end.

There are two pantographs on the roof of each locomotive, controlled by electrically operated air valves. The collectors are normally held up by the action of springs and are forced down by compressed air admitted to two cylinders. When down they are latched. To raise them the latch is released by admitting air to a smaller cylinder and the pantograph springs raise the trolley. The control of the pantographs is obtained with a two-way push button switch at each end of the locomotive. A hand pump is provided to release the latches of the pantographs if it is desired to raise them when no compressed air is available. Cut-out valves are fitted to enable either pantograph to be cut out of action if desired. The total range of the pantograph is 9ft. Shoe beams are also mounted on each side of each bogie. The shoes are connected together through fuse boxes mounted on the bogie side frame over the shoe beam, the shoes being similar to those used on the passenger stock. Two knife switches are fitted inside the locomotive to enable collector shoes or pantographs, or both, to be connected to the equipments.

The following table gives details of the electric locomotives :—

Distance between bogie centres	18ft. 6in.
Bogie wheel base	9ft.
Diameter driving wheels	4ft.
Length over buffers	43ft. 2in.
Length of cab	33ft. 6in.
Width of cab	10ft. 1in.
Height of cab	8ft.
Weight of complete locomotive	62½ tons
Weight on drivers	62½ tons
Weight of electrical equipment	22.3 tons
Number of motors	Four
One-hour rating of motors (75 deg. Cent. rise)	230 horse-power
Tractive effort on first step of controller	10,000 lb.
Current per motor at this pull	165 amperes
Diameter of armature core	1ft. 9in.
Length of armature core	1ft. 4¼in.
Diameter of commutator	1ft. 6¼in.
Length of commutator	$8^{17}/_{32}$in.
Teeth in pinion	18
Teeth in gear wheel	70
Length of teeth	6in.

For the reception of the electric rolling stock a new car shed has been built at Liniers. This shed is 500ft. long and contains eight tracks. The rails are raised from the floor on steel supports so that the equipment underneath the coaches can easily be inspected. Platforms hanging from the roof are also provided to facilitate the cleaning of windows and coach body work.

Power for moving the coaches in this shed is supplied from overhead trolley wires carrying small carriages from which hang cables that can be plugged into the train line sockets on the coaches. Adjacent to this inspection shed, a repair shop has been constructed. This contains four tracks and accommodation for about eight coaches. It is equipped with a small smithy and workshop, and there are two 20-ton travelling cranes. A small shed has also been constructed at Caballito sidings. In order to facilitate the training of motormen a complete electrical equipment of a coach has been erected in a special room at Villa Luro.

The Royal Society's Conversazione.

AMONG the exhibits shown at the Royal Society's Conversazione on Wednesday evening, one of the most interesting to the engineer was undoubtedly Dr. Hele Shaw's stream line filter. It was demonstrated at work on various liquids, such as very dirty water and oil extracted from a motor car gear box after extensive use, and in each instance was produced a sparklingly clear liquid, while the residuum could be drawn off from a separate tap, and all at a speed far surpassing that obtainable with filter paper and equals in fact, if not surpassing, that given by a filter press or any similar commercial device. The most striking instance of its efficiency was its application to the filtering of a solution of coal tar dye. The deep mauve liquid was actually being delivered as a crystal pure stream of water. It was actually holding back the coloured dye particles. What this means we have not yet had time fully to appreciate, but we gather that Dr. Hele Shaw's view is that the filter is capable of effecting molecular separation. The device, has obviously many practical applications, of which we believe we may hope shortly to hear something, but it is, nevertheless, exceedingly simple in principle, consisting in effect of forcing the fluid between two or three thousand sheets of non-absorbent paper. The paper is uncalendered, and the sheets are pressed together to an extent which is such that the magnitude of the spaces between them is governed by the roughness of the fibrous surfaces. Alternatively the paper may be smoothed by calendering, in which case the interstices are formed by printing quite lightly a stream line pattern upon them. One other factor of great practical importance is the facility and quickness with which the filter may be washed out, an operation which can be actually effected by means of the unfiltered liquid itself.

Professor H. C. H. Carpenter exhibited his remarkable mono-crystalline test specimens of aluminium, concerning the formation and mechanical properties of which he read a paper at the recent meeting of the Iron and Steel Institute. By means of a combination of strain and thermal treatment, Professor Carpenter has succeeded in transforming flat sheet and cylindrical specimens of ordinary aluminium containing about 3½ million crystals per cubic inch into specimens composed of but one crystal. The mechanical tests conducted on these specimens revealed many curious results, but as we hope to give a summary of Professor Carpenter's paper in next week's issue and to comment upon it editorially, we will not enter into the subject at greater length here.

Some most interesting photographic enlargements of films taken with the Heape and Gryll rapid cinema machine were shown, and an address thereon was given by Mr. Walter Heape, F.R.S. One series comprising sixteen successive views, showed the breaking of a 15in. Osram vacuum globe with a hammer. The exposures were made at the rate of 2500 per second. Between the second and the thirteenth an interval of about $^1/_{78}$th part of a second elapsed. This interval covered the actual break up of the globe. A second series of thirty photographs, made at the rate of 2000 exposures per second, illustrated the discharge of a 5in. diameter rubber ball shot from a gun against a target 26in. away. The contortions of the ball under the initial acceleration and the rebound from the target, all occurring within an interval of about $^1/_{40}$ second, could be clearly followed. The machine can take photographs at rates from 500 to 5000 per second, and is now in use at Shoeburyness for recording the results of gunnery experiments.

Mr. F. Harrison Glew showed an experiment—at present of purely scientific interest—consisting of the levitation of a bar magnet of 15 per cent. cobalt steel above the poles of a fixed magnet. The cobalt steel bar was confined between two glass plates so as to be free to move vertically, and was set with its north and south poles over respectively the north and south poles of the fixed magnet. The bar floated by repulsion ¼in. or more above the fixed magnet, and when depressed and freed returned to its original height, the value of which was determined by the strength of the field of the fixed magnet. The experiment was also demonstrated with two cobalt steel bars, one floating above the other. The scientific interest of the experiment lies in the fact that it cannot be performed with a bar of ordinary magnet steel, for the bar under the intense magnetic field required for flotation reverses its polarity and is attracted down to the fixed magnet.

Among other exhibits of engineering or allied interest, we noticed Professor Vernon Boys' recording and integrating gas calorimeter, which we described in our issue of a fortnight ago—shown by J. J. Griffin and Sons, Limited—the use of Rochelle salt as a piezo-electric crystal for the transmission to a telephone receiver of the vibrations derived from a gramophone record and needle—shown by the International Western Electric Company—and the results of various investigations and researches recently carried out in coal mines and elsewhere by the National Institute of Industrial Psychology.

Literature.

Merchant Ships of the World, 1923.—By FRANK C. BOWEN and F. J. N. WEDGE. Sampson Low, Marston and Co., Limited, 100, Southwark-street, London. Price £3 3s.

THIS volume of reference is original in its conception, and presents much valuable information in a manner which should ensure for it a wide reception in both technical and commercial circles. We have long been familiar with naval year-books, but it has remained for the authors to produce an illustrated and descriptive annual which, as far as we are aware, gives for the first time a complete account of the world's commercial ships. Not only has evident care been bestowed on collecting and compiling data and particulars relating to each ship and its service, but further than this, a scheme of identification has been evolved which is in itself one of the valuable features of the book.

After a brief foreword explaining the origin, purpose and applications of the new publication, there follows an alphabetically arranged index of the commercial ships of the world—we note the entries are between twelve and thirteen thousand in number—each with a reference to the descriptive particulars, the identification, and the nationality of the ship.

The first part of the book proper comprises that section devoted to the description of the ship, every vessel being listed under its shipping line, beginning with the United Kingdom and the British Dominions and continuing with the countries of the world. Each ship or type of ship is, as far as possible, illustrated by a photograph, which, although not large, is sufficient to reduce materially the task of identification, and impart a general idea of appearance. To quote the author's words: "There is no doubt that Lloyd's Register will always be the sheet anchor of the underwriter with its classification and details that only Lloyd's can give," but, on the other hand, there are many details of value not only to the insurance broker, but also to the shipbuilder and repairer, the shipper and charterer, the salvage concern, the marine superintendent and the passenger agent, which the present volume gives. The following is a brief summary of the particulars which are stated along with the name of the shipping concern, the colour of the funnel, hull, and the trade service. After the name of each ship, the date of building and the gross tonnage are given, followed by the draught and speed, the deadweight cargo capacity, the number of holds, the height of 'tween deck, the number of hatches, the size of the largest hatch with the length between perpendiculars and the rise of floor. The machinery particulars and other data include the type of machinery and the indicated horse-power developed, the displacement of the ship, the number and type of boilers and the total coal or oil bunker capacity, fuel burned per day and particulars of winches and derricks. The passenger accommodation and number in each class is indicated, and the size and power of the Marconi wireless equipment is given. Referring particularly to motor ships, we note that only in certain cases is the type of Diesel engine named. The inclusion of the type of engine would doubtless be of interest to engineers, and in view of the rapidly increasing number of motor vessels it might also be an advantage to distinguish these from the steamships in some simple manner.

The second part of the book is devoted to a system of identification based primarily on classifying the vessels under the number of funnels, and secondarily under the number of masts, shape of ends and the general outline of hull. Minor features, are given, such as the position and shape of deck-houses, with the gross tonnage and the trading route, which enable the main outline features to be confirmed. This section of the work should not only prove of interest to the naval and mercantile officer, but also to the yachtsman and many others who, during a cruise or a holiday at sea, find pleasure in recognising passing ships and turning up full details concerning them. Since the Armistice, and particularly during the last two years, a great deal of shipping has changed hands, and this fact has not been unnoticed, since a special addenda to part one, printed at the end of the book, deals particularly with these ships. We have no hesitation in congratulating the editors on the success of their joint enterprise and expressing the hope that "Merchant Ships of the World" has been launched on a long and useful career.

THE case of the three outstanding subsidiary companies to be absorbed by the Great Western, came before the Railway Amalgamation Tribunal on the 7th inst.; the Mansfield Railway (London and North-Eastern) was heard on Monday last, the 14th inst., and the three Southern outstanding companies on Wednesday.

A Seven-Day Journal.

A Year's Explosions.

THE forty-seventh annual report of his Majesty's Inspectors of Explosives, issued during the past week, contains a record in that for the first time in the history of the manufacture of explosives in the United Kingdom, no fatal accident occurred during the year in any factory established under the Explosives Act, the 51 accidents which occurred in the course of manufacture involving cases of injury only, and that to but 11 persons. In connection with the keeping of explosives, there were three accidents, involving injuries to two people, while in the conveyance of explosives there were no accidents. In the use of explosives, however, there were 326 accidents, involving the deaths of 52 persons and injury to 360. Of the accidents causing death or personal injury over 97 per cent. occurred in connection with the illegal manufacture of explosives or under miscellaneous conditions, to which the Explosives Act does not apply. The worst accident was that at Tipton, as a result of which 20 young girls lost their lives consequent upon the breaking down of miniature rifle ammunition under illegal conditions. Various irregularities in connection with shot firing caused 25 deaths, the most fruitful source of fatalities being failure to take proper cover. There are now 110 certificated or licensed factories making explosives in this country.

The Machinery Users' Association.

THE annual meeting of the Machinery Users' Association was held in London on Wednesday. The council's report was mainly concerned with the efforts made to secure the passage through Parliament of the Rating of Machinery Bill promoted by the Association. These efforts extend back to 1895. The aim is to secure that in estimating the rateable value of any hereditament in England and Wales used for trade business or manufacturing purposes, machinery shall not be included unless it is affixed or attached to the freehold or is used for producing or transmitting motive power or for heating, lighting, or ventilation. On nine previous occasions, including that of its presentation in April last year, the Bill obtained a second reading in Parliament, either without a division or by a large majority, but in all cases no opportunity occurred for completing the further stages. It was re-introduced this year, and was put down for second reading on Friday of last week, and once more it received a second reading by a substantial majority. In view of the fact, however, that the Government has in preparation a Bill dealing with the whole general question of valuation and rating, the Minister of Health intimated that he could not hold out any reasonable prospect that the Bill would be more successful on the present occasion than formerly.

The Helicopter Competition.

THE conditions governing the long-promised helicopter competition were published by the Air Ministry on Friday of last week. The requirements will be found summarised in a leading article in this week's issue, in which we discuss their technical bearing. Here it may be added that all entries for the competition must be submitted by April 30th, 1924, and that entrants need not necessarily be of British nationality. The Ministry does not reserve any right to purchase the winning machines or the patents under which they may be constructed. On April 30th, 1925, any machine entered for the competition which has not completed the tests or any of them is to be deemed withdrawn, so far as the uncompleted tests are concerned. In the event of any of the prizes not being awarded they will be offered again for competition within a further period of one year upon terms to be then announced. The competition is described as being applicable to helicopters or equivalent types of machines, and more specifically to such machines as can fulfil the tests prescribed, "independently of the existence of any buoyant structure or of power or assistance supplied from any source external to the machine." This definition would appear to permit the entry of machines of the aerofoil-helicopter type, in which part of the sustentation when in horizontal flight is derived from the lift of fixed wing surfaces.

Atmospheric Pollution.

IN the course of a lengthy report by the Public Control Committee of the London County Council on the pollution of the metropolitan atmosphere by smoke, strong complaint is made that Government property and buildings owned by local authorities or corporations or undertakings acting under statutory powers, should be exempt from the requirements of the Public Health Act. It is stated in this connection that the Royal Arsenal and the Royal Dockyard at Woolwich give rise to a serious smoke nuisance. The Committee expresses itself strongly against the continuation of the use of old-fashioned domestic fuel consuming appliances, but it does not charge them with being more than one of the causes of atmospheric pollution. Indeed, it seems to minimise their importance in this respect by the statement that of the eighteen million tons or so of coal consumed annually in London, only about 4¾ tons are used for domestic purposes. What it describes as "probably the larger factor in creating fog conditions in London" is the smoke arising from premises outside the county by the riverside and to the east of the river Lea. As regards industrial plants, locomotives and steamships which it is asserted are responsible for a large amount of preventable pollution, it is stated that they can be so constructed as to produce very little visible smoke. In this connection it may be recalled that in August last year the Council failed in its cases against the South-Eastern and the Brighton Railways for the emission of black smoke, it being held by the magistrate that the locomotives in question were properly constructed, and that it was not practicable to construct an engine that would entirely consume its own smoke. On the other hand, the London and North-Western Railway last November failed in a similar case, and was fined four guineas at Eccles for permitting the emission of black smoke from engines at the Patricroft sheds.

The Aeroplane Disaster.

THE disaster which overtook the French Air Union Company's Farman "Goliath" machine at Monsure, in the Somme Department, on Monday afternoon, while on its way to London, whereby all on board, four passengers and a crew of two, lost their lives, is now being officially inquired into, but from the completeness of the wreck, it seems highly improbable that any satisfactory explanation of the cause will be disclosed. The accounts of eye-witnesses seem definitely to establish the fact that the machine was on fire before it struck the ground, and that during, or just before, the descent one of the wings became detached and fell separately. With these facts alone available any explanation of the prime cause of the mishap must be a pure guess. The fact that once again it is a French machine which has suffered disaster has not escaped comment, and it has been more than suggested that French commercial aeroplanes do not receive the same attention from the point of view of safety—particularly in the matter of routine examinations between flights—as do British machines. It is certainly the fact that French aeroplanes employed on civilian services have been up to the present much more unfortunate than those of this country, although it must not be forgotten in this connection that the French commercial services are considerably more numerous than ours.

The International Navigation Congress.

MANY subjects of great importance to engineers will be discussed at the International Navigation Congress, which is to open at the home of the Institution of Civil Engineers in London, on July 2nd. The Congress is the thirteenth organised by the Permanent International Association of Navigation Congresses, and will be held under the patronage of his Majesty the King and the presidency of Lord Desborough. From a copy of the detailed programme just issued, we note that among the subjects to be discussed and reported upon will be the utilisation of waterways for the production of power, the accommodation to be provided in connection with new works at ports in order to satisfy the future dimensions of ships, berthing ships of great draught in tidal seas, the application of concrete to hydraulic works, liquid fuel for navigation, and tidal power for working and lighting maritime works. The Congress will be attended by representatives from the principal countries of the world, and will last a week, with the first three days of the second week devoted to visits to works in the provinces. Corporations and individuals may become temporary members of the Association for the purpose of attending the Congress, upon application to the honorary treasurer of the British Organising Committee, Sir Albert Wyon, at the Institution of Civil Engineers, S.W. 1.

Cargo Ships for the Great Lakes.

A RAPID piece of shipbuilding construction is about to be completed by Swan, Hunter and Wigham Richardson, Limited, which firm has within five months built and finished eight out of the nine steamers it has on order for the Canadian Lakes. During the last month the eight completed vessels have been dispatched to the St. Lawrence, and it is expected that all the ships will arrive in time for the opening of the spring navigation. The boats are about 250ft. long, 42ft. 6in. in breadth, and 20ft. 6in. deep, and have a raised quarter deck 100ft. long and a forecastle 35ft. 6in. in length. Among other special features, the wide cargo hatches may be mentioned, and the steam winches, which are provided to facilitate manœuvring and warping when the vessels are passing the locks. The living quarters for the officers, engineers and crew are spacious and well appointed. As the vessels are laid up during the winter the arrangements for the draining of the machinery piping have been carefully considered. Five of the ships were built at the company's Wallsend Yard, one at Neptune Yard, one at Southwick Yard, Sunderland, and one at Clydeholm Yard, Glasgow. The ninth vessel is being completed at the company's Londonderry Yard. The engines have been supplied by Swan, Hunter and Wigham Richardson, Limited, MacColl and Pollock, Limited, Sunderland, R. W. Hawthorn, Leslie and Co., Limited, Newcastle, Barclay, Curle and Co., Limited, Glasgow, and J. G. Kincaid and Co., Limited, Greenock.

A New Cable Ship.

ALTHOUGH considerable developments have taken place in wireless telegraphic communication during recent years, the field of submarine telegraphy remains unaffected if progress may be judged by the new cable-laying ships which are being built. In our issue of March 16th we gave a brief account of the Faraday, which ship is now being equipped with her cable machinery at Siemens Bros.' Works. On Saturday last a further cable ship for the Eastern Telegraph Company, Limited, of London, was launched from the yard of John Brown and Co., Limited, at Clydebank. The Mirror is one of two ships on order for the same owners, and her sister ship, the Norseman, will be launched shortly. The following are the principal dimensions:—Length overall, 270ft. 8in.; extreme breadth, 37ft. 2in.; moulded depth, 25ft.; gross tonnage, 1740 tons. The propelling machinery is of the twin-screw type, and the triple-expansion 1500 indicated horse-power engines are designed to give a service speed of 12 knots. There are three cable tanks having a total capacity of 16,000 cubic feet, which is equivalent to about 530 miles of cable. Specially large bow sheaves are provided, and two sets of the most modern type of cable-laying machinery will be fitted. We understand that the Mirror is the first cable ship to be built at Clydebank.

Sixty Years Ago.

OUR issue of May 15th, 1863, contained several articles and notes shedding an interesting light on the position of engineering in those days. In an article entitled "Brewery Economy," we read of some of the recent improvements introduced in the practice of making beer, but it was recorded that "breweries have hardly been brought within the domain of engineering," although their plant was of undeniable interest to the engineer. An article on the action of heat on iron explained in simple terms the effect on the strength of iron of the presence in it of carbon and silicon, and the influence of temperature in at first raising and then lowering the tenacity. The explanation was based on the existence of inter-atomic attractions, but while it no doubt appeared complete and satisfactory to the author and his readers, there is hardly one statement in it which modern developments do not contradict or challenge. In an article on "Mental Calculation," we find a miscellaneous collection of simple rules then in common use among engineers, such as that a 30 horse-power land engine, condensing, has a 30in. cylinder and a 3in. piston-rod, and that boilers for land engines require 1 square foot of grate area, 1 square yard of heating surface, and 1 cubic yard of capacity for each horse-power. In another article bearing the title "Paper Making," we reviewed and criticised a process for the manufacture of "ulmate of ammonia," as a side line at a Dartford paper mill. The substance, to be used as a fertiliser in place of Peruvian guano, was to be produced by the action of steam on rags of mixed cotton and wool. Before the Institution of Mechanical Engineers, meeting in Birmingham—its first home—Mr. D. K. Clark read a paper on "The Locomotives at the International Exhibition of 1862." Of the eleven English and nine foreign engines shown, most of them, it was recorded, were specially constructed for burning coal, a feature introduced entirely since the previous exhibition in 1851 and adopted because of the smaller cost for coal than for coke. In a note it was recorded that the failure of the wrought iron internal tubes of the Armstrong guns had now been admitted, and that preparations were being made at Woolwich for the manufacture of steel tubes, recent improvement in the production of steel permitting that material to be substituted for the iron hitherto employed "on account of its non-liability to burst when fired."

International Roads Congress at Seville.

(From our own representative at the Congress.)

No. II.*

IN an endeavour to estimate the value of the work done by an international gathering, due weight must be given to the language difficulty, which tends to prevent the complete interchange of opinion that the subjects under review demand. It must also be borne in mind that in order to secure uniformity in decisions reached the formal conclusions recorded can only deal with general principles. These drawbacks need not and do not imply that nothing useful has been accomplished at Seville. There was general agreement, indeed, among those who attend the Congress that excellent work was done not only at the official meetings, but also in the unofficial intercourse outside the Conference room which a week's companionship for a common object brings about. A particularly pleasing feature of the Congress was the close union between the British and American delegates for the purpose of impressing their views on those in other countries concerned with the construction and upkeep of roads, and the organisation, operation and regulation of road traffic. Private meetings of the English-speaking delegates were held each day in advance of the sectional meetings of the Congress, and the lines of a common policy determined. It fell to Colonel C. H. Bressey, the Chief Engineer of the Roads Department of the Ministry of Congress to put forward the views of the English-speaking nations, a task which he performed with skill and discretion, the result being that the views of engineers in Great Britain and America are strongly reflected in the final conclusions of the Congress.

ROAD SURFACING SYSTEMS.

Two of the most important subjects discussed in the technical section of the Congress were the surfacing of roads with concrete and the use of bitumen and asphalt for surfacing. It was recognised by representatives of other countries that British engineers had had longer experience of bitumen and asphalt roads, and that American engineers possess a more extended knowledge of concrete road construction than other nations. Recent work in connection with concrete road surfacing was the subject of comment in last week's issue, and the final recommendations of the Congress reflect, to a very great extent, the opinions of American engineers. The view taken by the Congress was that the case for concrete surfacing which has been the object of a well-thought out plan, and where the work has been executed with great care, has been established for roads which have to carry a heavy traffic of rubber-tired vehicles. It was also agreed that such roads adapt themselves to all climates. They resist the great temperature ranges met with in Canada and Scandinavia, and as the materials of construction are found in nearly all countries, the mileage of concrete roads is likely to show a somewhat rapid increase. This type is, however, heavy in first cost, and the work of construction calls for great care and attention to detail, which perhaps cannot always be obtained. The materials must, it is scarcely necessary to remind engineers, be chosen with discretion and with the circumstances of the particular case in mind. The Portland cement should be of extra good quality, and in some instances indicated it is recommended that special high-resistance cements should be used. The fine aggregates should be sand, free of all mud or organic content and containing only a small proportion of clay, while care must be taken to obtain correct gauging. Compactness of the cement is essential, and the determination of the exact proportions to obtain the necessary degree of compactness should be the subject of experiment. As a general rule the adoption of two-layer surfacing is not recommended, but if this method is adopted the second layer must be laid before the setting of the first is completed, and the whole rammed in one operation. Emphasis was laid, in the general recommendations, on the importance of employing absolutely constant quantities of water, the amount of which should be the subject of methodical study.

Other research work suggested is in connection with the utility, or otherwise, of expansion joints and the general question of crack formation. A non-committal attitude was adopted on the subject of the use of reinforcement and further experimental work was suggested.

BITUMEN AND ASPHALT.

What has been done by British engineers to obtain a satisfactory road at lower cost than by concrete was shown in the report on the use of bitumen and asphalt, which is the joint work of Mr. J. S. Killick and Mr. T. G. Marriott. It is made clear from this interesting review of the position that English engineers are looking to a more extended use of bitumen and asphalt to meet their requirements. Specifications for surfaces of this type have been broadened, so that those responsible for highway maintenance have a considerable choice and can specify an asphalt suitable for particular needs. Research has been put in progress to assist the work of finding suitable aggregates, and it is now possible for road authorities to draw up specifications of forms of construction and methods of laying two-coat asphalt. It is believed as a result of recent work that the sub-base of Portland cement concrete, which has been generally used, can be dispensed with. In such cases the method adopted is to lay from 2in. to 3in. of asphalt binder, and 1in. to 1½in. of surfacing. Rock asphalt is the material *de luxe*, and in the streets of London has proved to be the most durable form for heavy traffic. Its high cost is, however, likely to rule it out for general use.

Where bitumen is used it is of either the Trinidad or Mexican variety, and upwards of five million square yards of roads in Great Britain have been the subject of experiments with bitumen surfacing. This application of bitumen is laying the foundations of an important branch of road engineering. Confidence is expressed in the report that a definite formula will be evolved which will enable a suitable one-course pavement to be adopted for the purpose of surfacing main country roads. The solution of the difficulty of finding a suitable one-coat mixture would seem to be in the precise adjustment of the stone content with that of a mixture of sand, bitumen and filler.

The conclusions on the subject indicated a general acceptance of the view that British experience had already made out a case for a satisfactory form of two-coat asphalt, and French experience a fairly satisfactory one-coat surfacing. Methods of making and laying have been determined, and the qualitative determination of the mixtures is known. There are, however, doubts as to the quantitative determination which is a function of the traffic, and the climate. Standardisation of the aggregates and bindings is not regarded as desirable. More research work is needed, particularly as to the proportions of materials for aggregates and their sizes.

MECHANICAL APPLIANCES.

Reference is made in many of the reports to the changes which have been brought about by the new traffic conditions in the appliances used in road construction and maintenance, and attention should be directed to the special reports on this branch of the subject. These reflect the considerable progress made during the past few years in assisting those responsible for road work to meet the demands made by traffic, 97 per cent. of which is mechanically propelled.

The British reporters are Mr. Albert E. Brookes, engineer and surveyor to the Durham County Council, and Mr. Arthur E. Collins, city engineer of Norwich. Dealing with tar-macadam plant, stress is laid on the need of efficient drying units, and in British practice the heated floor method, although undoubtedly the most efficient, is giving place to the double cylinder type of dryer, which has proved satisfactory. These machines are said to be capable of an output of 25 tons an hour. French engineers employ various types of machines, including the Ammon, the Campistron, the Ransome, and a more recent type made by the Société de Constructions Mécaniques de la Savoie. The American report refers to the failure of the attempt to utilise concrete mixers for the production of asphalt and bituminous surfacing materials by the introduction of a hot blast. The total inefficiency of this hybrid machine has led to its replacement by specially designed machines in which particular attention has been paid to the construction of the fire arch to increase the efficiency of the dryer.

The distribution of bituminous material by hand pouring and by machines with a gravity flow has been largely abandoned in favour of machines working under pressure. The greatest advance in distributors is in the motor truck type. Many of the large asphalt and tar companies maintain a fleet of such trucks to distribute their materials from central supply stations. Material is hauled in these trucks and applied on work sometimes as much as 50 miles away from the central plant. A large part of the material used for road oiling, surface treatments and for penetration work is now applied by motor truck distributors. Motor truck distributors are made with tanks from 800 to 1000 gallons capacity. It is possible with most makes to fill the tank of the distributors from tank cars by the equipment which develops the pressure so that an additional pump for this purpose is not always required.

Among concrete mixers the "Aero" is commended, and the English report refers to the new principle involved of blowing the cement on to the damp aggregate instead of the usual dry and wet mixing. One advantage of this method is said to be that it reduces the quantity of cement required to make a given quantity of good concrete. This machine is also employed in French road work. Loading machines are now being commonly used, and although they are not intended to supersede the storage hoppers they are useful appliances. One in use at Norwich is said to be capable of loading road shingle into wagons at the rate of 1 ton per minute. The loading and transport of raw materials is so important a factor in road making that American engineers have given the subject a good deal of study. The direction in which they have sought for a reduction of transport costs is in the development of the narrow gauge industrial railway. The usual gauge is 24in. and the rails used are mostly of the 25 lb. type. The cars can be used not only for grading but for a variety of other purposes, but the best function of these railways is for transporting materials for the construction of the road surface. The size of the trains varies from four cars to thirty, and although the old 6-ton locomotive is still used to a great extent, the 3-ton and 9-ton engines are also employed. The steam engine has given place to a gasoline propelled locomotive. The point which will appeal to road engineers is that materials can be conveyed at 7½ cents—say, 3½d.—per ton-mile, and indeed it is claimed that as low a point as 5½ cents per ton-mile has been reached. New developments of this system are in near prospect. The difficulty of devising a satisfactory and efficient method of loading blasted rock has not yet been solved in cases where the cut is shallow and large lumps of material have to be handled. For ordinary pit and quarry work the steam shovel, with track or caterpillar traction, has been a great success. Use of the cable line and dipper remains standard practice for taking gravel from water, but a recent development is the front continuous dump dipper, which it is said does not, like the rear dump dipper, lose capacity by the time taken in closing.

For road excavation work an increasing use is being made of small hammer-rock drills and compressed air machines, and these have been seen at work during a recent period in London. The augur drill, the bit of which cuts like an ordinary hammered bit but removes the chips, is a recent development which has found favour. When deep holes are required the old percussion type of drill is preferred, and it is a tool, as the report on American practice states, the details of which have been much improved.

In connection with the mechanical appliances section, a small exhibition of machinery was held in the grounds adjoining the Congress Hall. The British firms who sent machinery were Marshall, Sons and Co., Ltd., and Aveling and Porter, Limited. The first named sent out to Seville a 10-ton compound steam road roller fitted with the Allen type scarifier, and the Aveling and Porter exhibit was an 8-ton steam road roller, also fitted with a scarifier. Demonstrations were given daily with both machines.

LAYING OF TRAMWAY RAILS.

Nor should mention be omitted of the group of reports which deal with the laying of tramway tracks on various kinds of road surface. Mr. John A. Brodie reports on English practice, and has obtained the co-operation of the engineers of all the big cities on a somewhat controversial subject. Experience points, he indicates, to the conclusion that when tramways have been laid on streets where traffic is heavy and continuous, there is need for using stronger and heavier sections of rail. The space formerly left at the joints for the purpose of expansion and contraction has been done away with, and the welding of the rails at the joints or, alternatively, the welding of the fish-plates along the top and bottom of the rails throughout has been found to be advantageous. Tramways so laid are stated to be giving excellent results as regards freedom from heavy costs of maintenance and an extended length of life.

Some general conclusions which can be drawn from the nine reports presented may be stated. While it is not considered possible to lay down definite rules regarding construction, one or two points are emphasised for the guidance of engineers responsible for tramway systems. It is recognised that the laying of rails on a road increases the cost of the road, and adds to maintenance charges, and a plea is put forward for the laying of tramway rails on ground apart from the general traffic zone. Special attention must, it is insisted, be paid to foundation drainage. In cases where the road is paved with macadam or stone, and where the traffic is small and the weight per car axle does not exceed 5 tons, the rails can be laid directly on the natural ground. Where the traffic is intense and the cars heavy, the track should be laid on hydraulic concrete cement, and where the traffic is less intense, concrete longitudinal sleepers can be employed. The rails may rest upon wooden or steel cross ties embedded in the concrete or on anchorages embedded in it, but the former method is to be preferred as giving greater elasticity to the track. In the majority of cases it will not, however, be necessary to employ such supports; the rail can rest upon the concrete surfaces if care is taken to secure continuous contact between the foot of the rail and the platform. Rails with a lateral groove must, of course, always be laid in streets, the Vignoles type being reserved for use on separate track. The Sandberg method is recommended for hardening the heads of the rails. Special consideration is given in most of the reports to the means which should be adopted of preventing noise and vibration. Mr. Brodie expresses the opinion that no modification or improvement in the track will eliminate noise, and that attention must be devoted to the improvement of the working parts of the vehicles. In particular, the gears and motors should, it is suggested, receive attention. There is room, it is added, for a new type of tramway car. The rivalry of the motor omnibus with the tramway was not discussed, but the omnibus is making headway, not only in France but

* No. I. appeared May 11th.

even in Spain, where in the streets of Madrid and Barcelona the Tilling-Stevens omnibus is now a familiar object. The opinion of the traffic experts assembled at Seville is that both methods of transport will persist.

MOTOR TRAFFIC.

The motor traffic section of the Congress had several important subjects before it, including the vexed question of the relative functions of road and railway transport. A proposal has been put forward for an International Diplomatic Conference for the purpose of establishing a uniform code of traffic regulation to apply in all countries. This idea was approved, but the proposal of the French delegates that the development of motor traffic should be assisted by Government subsidies was not favoured by representatives of the English-speaking nations. New carburants to cheapen cost of operation, improvements in vehicle design and weights and speed restriction were discussed. The lack of terminal facilities was criticised, and it was suggested that in this connection the best line of development would be the formation of separate companies to develop the terminal facilities and allow owners of motor vehicles to make use of them on a rental basis. The report contributed by Mr. E. Shrapnell Smith, with whom Mr. J. S. Pool Godsell, of the Ministry of Transport, and Mr. J. W. Watson collaborated, dealt with dimensions of vehicles, weights and speeds, tires, lighting and brakes, and many other aspects of the question. The conclusions drawn from this review may be summarised. They are that the rigid exclusion of any type of road vehicle from any class of highway is in the national interest eminently undesirable until every alternative has been exhausted. When selection becomes necessary, it should apply, it is suggested, to through traffic in the first place, for which arrangements should be made by another route, and thereafter, if imperative, to the larger or heavier vehicles only. Regulation of user, in varying degree, should thus be possible in most cases, and prohibition should only be accepted as the solution where some undeniable element of danger is insusceptible of amelioration or removal except at exorbitant cost out of all proportion to the advantages to be obtained. The powers already possessed by the Minister of Transport under sec. 7 (4) of the Roads Act, 1920, are regarded as covering all requirements. Their exercise depends upon the initiation of applications by County or County Borough Councils, and provision is made for a public inquiry in each case. Many such applications have been received and orders made. The report refers to the great value of the facilities for conference, and adjustment of differences or disputes, which the existence of the Ministry of Transport affords as between road makers and road users. It is due to this provision for reaching settlements by negotiation concerning traffic routes and other essential matters that very large sums of money are saved annually in respect of road maintenance.

The subject of vehicle weights and capacity is dealt with in the American report, and statistics are quoted to show the very close relation of capacity to cost of transport. The saving under this head alone would, it is argued, establish the case for the outlay on building roads capable of withstanding the passage of heavy loads at high speeds.

The problem of traffic on congested streets and roads is an urgent one, and the British point of view was embodied in a report by Mr. W. Rees Jeffreys and Mr. Albert E. Cave. They are critical of existing conditions, but put forward definite schemes of amelioration, whereas most criticism of traffic congestion is not constructive. Some of the reforms suggested are the provision of parallel relief routes—segregation of traffic and better co-ordination with the railways. There is no doubt that traffic which ought not to use the streets has been forced to do so by the failure in many instances to link up by rail routes railway stations and docks, and as the report on the subject points out, this is particularly so in London. The same is true of Liverpool. Each town should have a railway goods clearing house linked by railway with the docks, or alternatively the railway stations should be linked up by loop lines. The proposal that the organisation of road traffic should rank as a science was welcomed by delegates. It is worthy perhaps of being made the exact science for which the English reporters on the subject put in a plea. They want to see a Road Traffic Committee for all the great cities, and they point out that a useful lead in this direction was given by the Traffic Sub-committee which was set up by the Ministry of Transport.

Many other branches of the traffic question received consideration, but owing to the widely varying conditions in the countries represented at Seville, nothing more than the general aspect of these subjects could be embodied in the conclusion of the Congress.

CONCLUSION.

On the social side the Spanish hosts did all that was possible to make the Congress an enjoyable function, without encroaching on the business part of the proceedings. Visits of inspection to the town and environs, including a trip on the Guadalquiver were embodied in the programme, a gala orchestral performance was given at the theatre, a garden party and a fête Andalouse was arranged and a bull fight organised. Interest in the function was displayed throughout by the Spanish Royal Family—his Royal Highness Don Carlos and Doña Luisa and Doña Isabel taking part in the opening of the Congress and other functions. The weather, too, was all that could be desired—warm without being oppressive. Sunny Spain at its best.

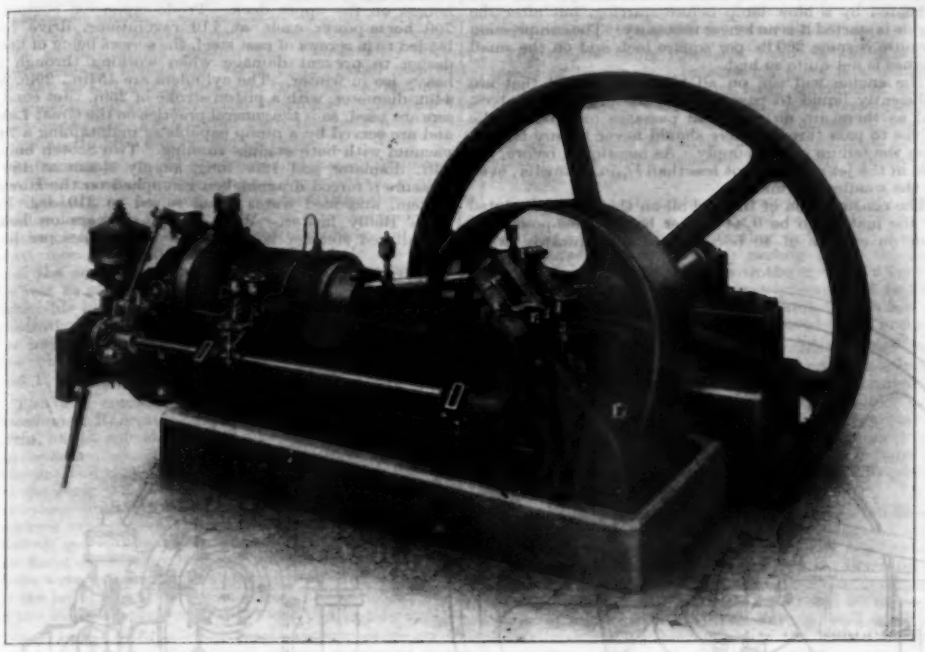

FIG. 1—ROBSON SOLID-INJECTION OIL ENGINE

A Solid-injection Crude Oil Engine.

We have recently received particulars of a new type of crude oil engine which is being manufactured by John Robson (Shipley), Limited, of Alexandra Works, Shipley, Yorkshire. This engine, of which we give illustrations, is, it will be noticed, of the horizontal type. It works on the four-stroke cycle, and is made with a single cylinder in several sizes ranging from 14 up to 100 brake horse-power, while with twin cylinders outputs of from 110 to 200 horse-power can be obtained.

A noteworthy feature of the design of this engine is the facility with which it can be changed over for working with gas instead of oil as fuel. The conversion is effected by taking off the fuel pump bracket, replacing it by a bracket carrying a magneto and gear, and also taking off the hot bulb and replacing it with a plate which carries the ignition plug. The inlet valves require changing, but not the inlet body or casing. The compression pressure naturally needs lowering, and it is therefore necessary to shorten the connecting-rod by removing the compression plate or to put in another piston. The whole operation is a comparatively simple matter and can, we are informed, be accomplished in one or two hours.

Referring to the line drawing—Fig. 3—it will be seen that the bed is made in box section and is so devised as to support the full length of the cylinder liner. It is dished at the bottom in order to prevent any waste lubricating oil from running on to the concrete foundation. The liner, which is made of cast iron, is put into the bed from the back end, and is held in position by the breech end casing. The joint of the front end of the liner is made on the outside with a rubber ring and plate. This type of expansion joint is naturally very convenient, as if at any time there should be a leakage it can be repaired without drawing out the liner. The cylinder breech end has been designed as symmetrically as possible in order to allow equal expansion to all parts. The inlet and outlet ports are arranged so as to give very free passage to the incoming air and outgoing exhaust. There are also ports for the self-starting valve on the right-hand side and for the hot bulb or vaporiser at the back. The connecting-rod is of the usual marine type, while the crank shaft is a solid forging in Siemens-Martin steel and is fitted with cast iron balance weights. The main bearings have gun-metal shells lined with anti-friction metal and are lubricated by ring oilers, as shown in the sectional view. The crank pin bearing is lubricated by a centrifugal ring oiling attachment. The crank shaft has a large swell on the extended part for carrying the fly-wheel and pulley—see Fig. 1—and the end of the shaft is supported in an outer bearing.

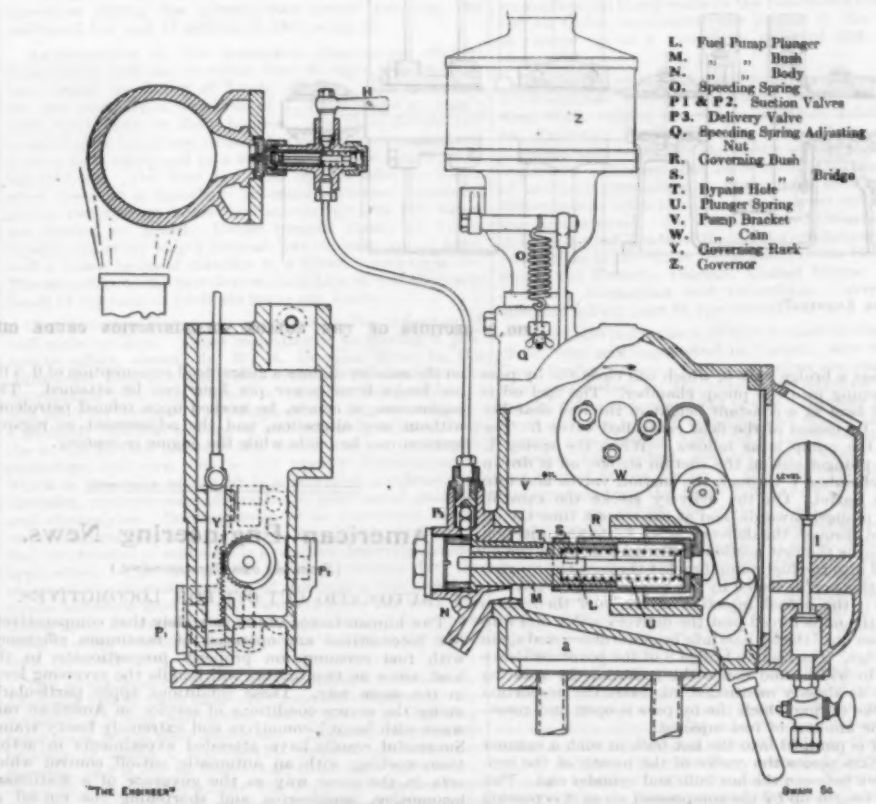

FIG. 2—DIAGRAMMATIC SECTION THROUGH FUEL PUMP, ETC.

The piston is made extra long and is fitted with sufficient rings to enable the compression pressure to be held without any appreciable leakage. The gudgeon pin, which is hardened and ground, is of very large dimensions in order to reduce the wear to a minimum.

The air valve and exhaust valve are made with cast iron heads and mild steel spindles, and are arranged vertically one above the other in the breech end. The air valve has a loose body and the exhaust valve spindle is carried in a loose guide which can be easily renewed if wear takes place. The arrangement is such that the bend of the exhaust outlet is relieved of all stresses. Both valves are actuated from a single cam, which makes a simple and efficient job.

The fuel pump—see Fig. 2—has a gun-metal body and is fitted with steel ball valves and a hardened steel bush in which the plunger works. The plunger is also hardened steel and ground to fit the bush, so that there is no need of packing to prevent leakage. The plunger is actuated by a quick-acting hard steel cam, so shaped that it delivers the oil at a high velocity to the injection valve box.

On reference to Fig. 2, it will be seen that the plunger L works inside the steel bush M, which is fixed in the fuel pump body N. The suction valves are marked P1 and P2 and the delivery valve P3. The governing bush R is supported on the outside of the bush M and works to and fro with the pump plunger. It is also free to rotate under the control of the governor Z and the rack Y. The governing bush has a bridge part S, which can close the by-pass hole T opening into the pump chamber. The fuel oil is fed to and kept at a constant height in the fuel chamber bracket V by means of the float controlled valve I. The action of the pump is as follows:—When the spring U forces the plunger out on the suction stroke, oil is drawn from the chamber V through the suction valves and into the pump barrel. On the delivery stroke the cam W forces the plunger inwards, and at the correct time the oil is delivered through the delivery valve P3 to the injection valve. During the first portion of the inward stroke the oil is returned into the fuel pump bracket through the by-pass hole until this port is sealed by the bridge S on the governing sleeve; the actual injection of the fuel then takes place and the oil is forced past the delivery valve and into the vaporiser until the by-pass hole becomes uncovered again by the bridge. The sealing bridge S of the governor sleeve are taper in width, and hence the governor, by rotating the sleeve, as already mentioned, regulates the proportion of the stroke during which the by-pass is open and consequently the amount of fuel injected.

The fuel is pumped into the hot bulb in such a manner that it strikes across the centre of the mouth of the connecting neck between the hot bulb and cylinder end. This jet is then caught up by the compressed air as it is passing through the neck towards the end of the piston stroke, thus breaking up the fuel oil and thoroughly mixing it by the turbulence caused in the hot bulb. The time of injection can be varied by a hand lever on the excentric fulcrum pin of the rocking lever which actuates the fuel pump.

The injection valve box is a simple gun-metal body containing a check valve, a steel bush, and a jet having only a single plain hole not less than $^1/_{16}$in. diameter, even on the smallest engine. A chamber *a* is formed at the bottom of the fuel pump bracket and can be connected, if required, for the purpose of warming the fuel, to a tee in the exhaust pipe near the engine. It is, however, only necessary to connect up and use the heater in cold countries or where fuel oil of a high viscosity is to be used.

All these engines of 22 brake horse-power and upwards are fitted with a compressed air self-starter, which is arranged with a valve on the breech end for opening when starting. The admission of the compressed air to the cylinder is controlled by an automatic valve worked by a cam on the side shaft. The piston and exhaust valve spindle are lubricated by a force pump driven by cam on the side shaft. The piston pin receives a separate supply and does not depend on the oil which is supplied to the piston. The cam shaft and governor gear wheels and the fuel oil pump cam run in oil baths.

No water injection is used to control the heat of the hot bulb, and it will, we are told, retain its heat properly on light load, or even on no load, automatically. The bulb is heated by a blow lamp before starting, but after the engine is started it is no longer necessary. The compression pressure is some 260 lb. per square inch and on the small engines is not quite so high.

The engine will run on all kinds of fuel oil that are sufficiently liquid to pass through the pipes and valves, and as there are no restricted passages or small needle valves to pass through there should never be any trouble from the failure of fuel supply. As mentioned before, the hole in the jet nozzle is not less than $^1/_{16}$in. diameter, even on the smallest engine.

The consumption of the fuel oil on this engine is stated by the makers to be 0.44 lb. per brake horse-power per hour on engines of 40 horse-power and upwards, while on the smaller engines a guaranteed consumption of 0.5 lb. per brake horse-power per hour can be attained. The engine can, of course, be worked upon refined petroleum without any alteration, and the adjustment as regards ignition can be made while the engine is running.

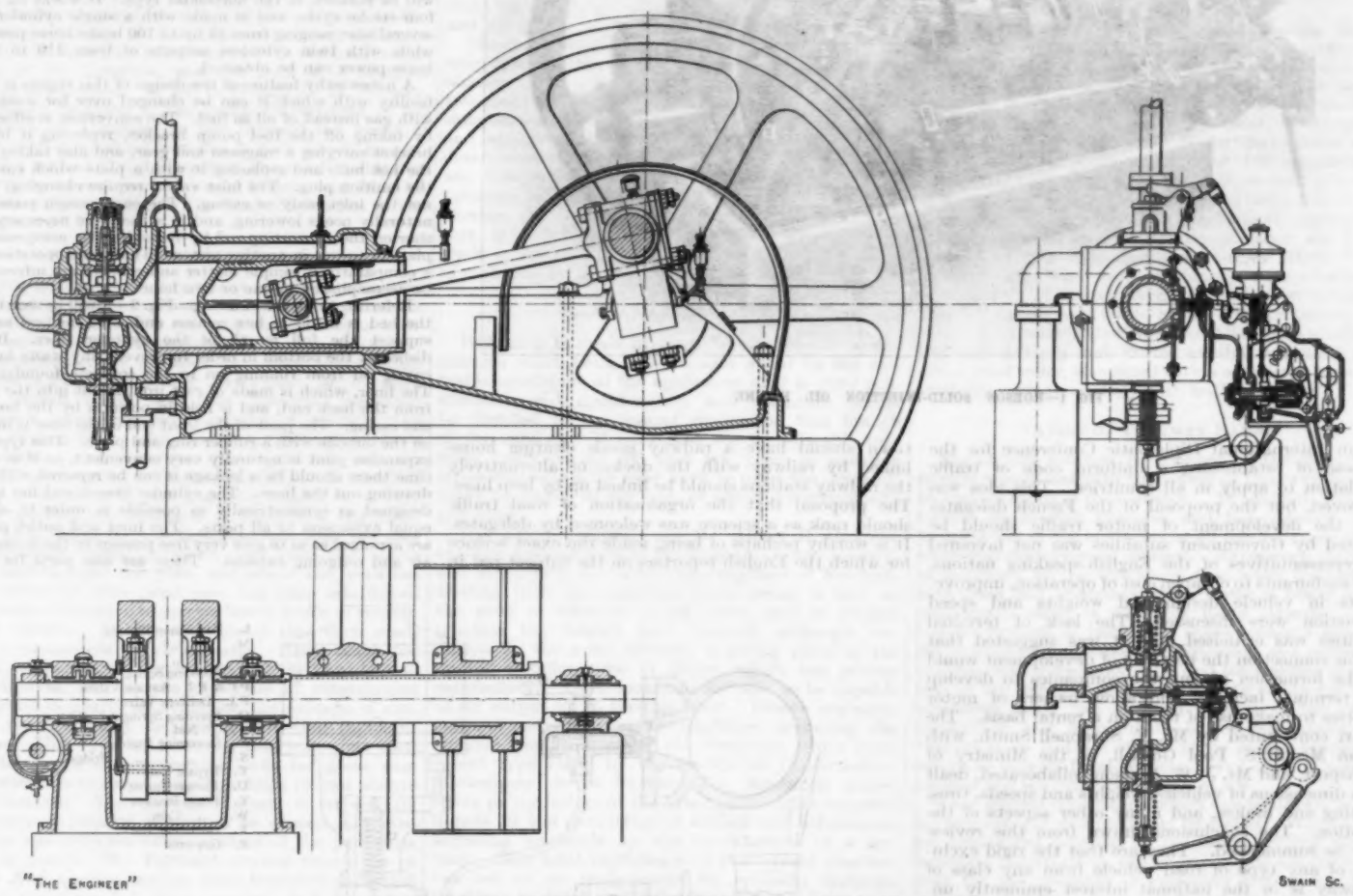

FIG. 3—SECTIONS OF THE ROBSON SOLID-INJECTION CRUDE OIL ENGINE

American Engineering News.

(From our own Correspondent.)

AUTOMATIC CUT-OFF FOR LOCOMOTIVES.

THE human factor varies so widely that comparatively few locomotives are operated at maximum efficiency, with fuel consumption properly proportionate to the load, since no two drivers will handle the reversing lever in the same way. These conditions apply particularly under the severe conditions of service on American railways with large locomotives and extremely heavy trains. Successful results have attended experiments in actual train-working with an automatic cut-off control which acts in the same way as the governor of a stationary locomotive, lengthening and shortening the cut-off as the load increases or decreases. But while in the stationary engine the aim is to secure uniform speed, such a thing is impracticable with a locomotive. The apparatus now in use is based on the principle that the length of cut-off is properly a function of cylinder back-pressure, there being a certain constant back-pressure which, if maintained, will ensure maximum output or efficiency at all speeds. On this basis, therefore, mechanism is arranged to actuate the cut-off in such a way as to maintain a prescribed back pressure. This apparatus has been in operation for some months on a four-coupled 4–4–2 passenger engine, and an eight-coupled 2–8–2 goods engine of the Cleveland, Cincinnati, Chicago and St. Louis Railroad. The engines take heavier loads and make better time with less coal consumption than similar engines with ordinary manual operation of the reversing lever.

LENGTHENING A CAR FERRY.

CAR ferry steamer No. 3, of the Ann Arbor Railroad, operating across Lake Michigan between Frankfort and Manitowoc, has been lengthened 48ft., the work being done in the steel floating dry dock of the Manitowoc Shipbuilding Company. New engines and boilers were also installed. The No. 3 is 307ft. long, and has the high freeboard of an ordinary steamer, but the stern is open, so that railway wagons can be run in and out of the main deck. Quarters for the officers and crew are in deckhouses on the upper deck. Triple-expansion engines of 700 horse-power each, at 110 revolutions, drive four-bladed twin screws of cast steel, the screws being of heavy design to prevent damage when working through the heavy ice in winter. The cylinders are 15½in., 26in. and 44in. diameter, with a piston stroke of 26in. Jet condensers are used, as is the general practice on the Great Lakes, and are served by a pump capable of maintaining a 24in. vacuum with both engines running. Two Scotch boilers, 13ft. diameter and 12ft long, supply steam at 180 lb. pressure; forced draught being supplied on the Howden system, and feed water being raised to 210 deg. Fah. by a Reilly heater. With twenty-six cars on board, the altered steamer has made 13 to 14 miles per hour, the engines running at 105 revolutions. This railway started its car ferry service in 1890, and has four steamers in service, all built to maintain regular service during the severe conditions of the winter months.

THE DESIGN OF EARTH DAMS.

IN a paper read before the American Society of Engineers by Mr. J. D. Justin, six points were noted as essential for the safety of earth dams. In the few safe dams which do not meet these conditions, special means have been adopted to overcome special difficulties. First, the dam should have sufficient spillway capacity to ensure against the danger of flow over the dam. Neglect of this condition has been the cause of many failures, and several dams now in service have spillway capacity insufficient for floods that may be expected. Secondly, the line of saturation must come well within the downstream toe. Thirdly, the slopes must be such that with the materials used they will be stable under all conditions. In general, the slope of the upstream face should be not steeper than half the angle of repose of the material in air, and in any case not steeper than 1 in 2. The slope of the downstream face will be governed by condition No. 2. In dams more than 30ft. high, wide berms should be formed to prevent erosion by rain. Fourthly, there must be no opportunity for the free passage of water from the upstream to the downstream face in such well-defined passages that the flow is greater than that which could be classed as seepage. Such passages may occur along pipes or conduits or smooth concrete abutments, through pervious or improperly bonded layers, or through holes formed by burrowing animals. Fifthly, water which passes through or under the dam must have a velocity so small that it cannot move any material from the dam as it leaves the toe. Sixthly, the freeboard must be sufficient to ensure against overtopping by wave action.

Railway Matters.

THE Darlington Town Council has appointed a committee to determine how suitably to celebrate the centenary, in September, 1925, of the opening of the Stockton and Darlington Railway.

THE installation of labour-saving plant and machinery at the new wagon-building shops of the London and North-Eastern Railway at Doncaster, has brought the capacity up to 10,000 wagons a year.

THE Railway Amalgamation Tribunal gave judgment on Thursday, 10th inst., as to the terms under which the Caledonian Railway Company is to come into the London, Midland and Scottish group. The decision announced was almost wholly against the Caledonian's claims, and virtually upheld the views of the larger company. It may be added that there can be no appeal against the judgment, and that since the beginning of the year the Caledonian has, for working purposes, been part of the London, Midland and Scottish system.

ADDRESSING a body of commercial men in Manchester, gathered together by Sir Edward Stockton, the chairman of the London, Midland and Scottish Railway, said on Friday last, that he was anxious to disabuse their minds of the idea that the recent amalgamations meant, in any way, monopoly. It was going to be quite the reverse, and the competition between the various groups would be just as severe as heretofore. Later in his remarks he asked his hearers not to be unduly impatient. The organisation of the traffic section of the company had so far improved that 83 per cent. of the traffic handed to the company reached its destination on the following day, and 13 per cent. on the second day.

THE golf course and hotel at Gleneagles, which the Caledonian Railway Company is seeking powers to complete, had a splendid advertisement when the Bill came up for second reading on Tuesday, the 1st inst. Mr. J. H. Thomas said that nearly a thousand men were employed on the work, that when it was finished more trains would be necessary, and that that was a good thing for the class of workers he represented, whilst Mr. Renner observed that leading golf professionals had said that Gleneagles was the finest course they had ever played on, and he believed there were hundreds of southern golfers who would flock to the hotel when it was completed. The second reading of the Bill was obtained by 163 votes to 40.

THE presence of a third man—an inspector—on the footplate of the up East Coast express concerned in the fatal collision of February 13th, at Retford, called forth the following remarks by Colonel Pringle: "His position would be on the fireman's, or left, side of the cab, and it may be assumed that, as a driver, with little to occupy his attention on the journey, he would, as a matter of course, be observing the outdoor signals. It may be argued that the presence of a third trained observer, posted in a better position than the driver for the observation of signals fixed on the left of the track, should be a source of additional security. But, unfortunately, the circumstances in this case do not support the argument."

AMONG the "City Notes" in *The Times* of the 30th ult. was a paragraph as to the investors in railway stock desiring more information regarding the earnings of the various companies than is at present supplied. Such information, we would at once say, was given when the railways were under Government control, and appeared in the Ministry of Transport's monthly statements of receipts and expenditure. It could, therefore, be given, but it should be pointed out that it has not been asked for until recently. Some of the members of the Committee which held the inquiry that led to the Railway Companies (Accounts and Returns) Act, 1911, were representatives of the general public and they made no such recommendations in their report. Actually, their work made matters worse than they were, as prior to 1913 the accounts were presented half-yearly instead of annually as now. Moreover, not until 1925 will comparative figures generally be available.

SPEAKING at the Railway Benevolent Institution annual dinner on the 8th inst., and alluding to the difficulties that force the companies to reduce rates and yet pay their way, Mr. William Whitelaw, the chairman of the London and North-Eastern Railway, said: "We have been disappointed in recent hopes of help from the railway unions. I do not blame them altogether. They seem to have been misled by public statements for which there is no foundation. Our mutual difficulties would be more easily healed if people who represent neither railway capital nor railway labour would mind their own business. The resources of the Railways Acts are not yet exhausted, and ultimately, I believe, we shall settle these difficult labour questions by the application of reason and common sense on both sides. Obviously, we cannot at once meet the present situation by a modification of labour conditions nor can we expect to meet it to any extent by savings due to amalgamation. These possible savings have been grossly exaggerated."

ABOUT 7.25 on the morning of January 17th the signalman at Pollokshaws South signal-box lowered his signals for an up mineral train to proceed along the up main line. When the train was quite close to the home signal the man threw that signal to "danger," and opened the points to turn the train into the up loop. The driver failed to notice the change and that he had been turned into the loop. He assumed that his train was still on the main line, and seeing the main line home signal at the next box—under 400 yards ahead—in the "clear" position, he maintained his speed. The loop was only a short one and had buffer stops at the end and behind them the signal-box. The engine crashed into these and swept itself, signal-box, driver, fireman and signalman down an embankment to the edge of a public road. The signalman was buried in the *débris* of his box and, with the enginemen, suffered severely from shock and injuries. Colonel Mount has recently reported on the accident, and says of the signalman that "the course he adopted warrants severe censure." He remarks also that, owing to the curvature of the line, the driver would not realise that his engine had passed on to the loop.

Notes and Memoranda.

A TELEGRAM has been received from H.M. Surveying ship Iroquois, stating that two volcanic islands, in southern portion of the China Seas, off Cochin China, are erupting, the first 97ft high, latitude 10° 10′ 20″ North, longitude 109° 00′ 10″ East, the second, 1ft. high latitude 10° 08′ 12″ North, longitude 109° 00′ 30″ East.

THE latest thing in wireless direction-finders has just been installed on the Cunard liner Mauretania. With this apparatus it is possible to ascertain in a few seconds the ship's bearing towards any one land station, or if touch is secured with two or more land stations the exact position of the vessel is easily found by cross-bearings.

OIL is now being recovered from certain oilseeds by means of liquid air. In America there is a number of hard-shelled nuts, containing large amounts of oils, but which are difficult to de-pericarp. It has now been found that if the nuts are dipped for a moment in liquid air, the shells become so brittle that they can then be easily broken. The liquid air is said to have no influence upon the taste of the oil.

COPPER naturally undergoes a slow process of oxidation in air, resulting in a coating of carbonate known as *verdigris*, which inhibits further corrosion. The best method for protecting copper castings is for the casting to be done under hot water, with the metal at a very high temperature. This method, largely employed in Japan, forms a coating of red cuprous oxide, which has been known to give protection for upwards of thirty years.

IT is reported in the *New York Herald* that Dr. de Forest has invented a speaking flame and expects immediately to be able to apply it to "talking pictures" and broadcasting. He is also said to have invented a "reversal" of the thermophone for the same purpose. In this apparatus a wire heated to a dull red electrically, changes its resistance when the sound waves impinge upon it so that a representation of these waves can be obtained in the microphone.

THE Canadian Department of Mines, states the *Chemical Trade Journal and Chemical Engineer*, has issued a lengthy report calling attention to large and easily accessible, but as yet unexploited, bodies of the mineral ilmenite, from which the pigment titanium white is made. Important deposits occur within distances of 70 and 90 miles from Montreal and Quebec City respectively, and small shipments have already been made to the United States for use in the manufacture of ferro-titanium.

AN interesting three days' trial was run at the works of the Parsons Motor Company, Limited, Southampton, during last week end. The engine tested was one of the firm's standard four-cylinder marine 28 horse-power units, having cylinders 4¼in. bore by 6in. stroke, and running at a speed of 890 to 900 revolutions per minute. After completing the usual four hours' efficiency trial, the fuel strainers were inspected and the engine connected to a Froude water brake. The unit was restarted at four o'clock on Friday afternoon, and was run without intermission throughout the week end, and finally shut down on Monday afternoon at the same time. The total consumption during the seventy-two hours' run was 195 gallons of fuel and 11 gallons of lubricating oil.

AN invention for the automatic illumination of lifeboats when they are launched from a ship's side has just been tested by Board of Trade officials. The inventors are two partners in the firm of T. Blair and Co., ship's store merchants, in East London. By their device two small electric lamps are switched on by contact established from a float contained in a tube fixed to the sternpost of the lifeboat. The float is forced up the tube by water when the boat is launched. Storage batteries capable of giving twenty-four hours' continuous light to the lamps are carried on board. Under present Board of Trade regulations every ship's lifeboat has to carry an oil lamp and a dozen boxes of matches in a sealed water-tight tin. The inventors of the new device claim that it will eliminate much of the risks of lifeboats being run down.

CONTROVERSY frequently rages about the influence of mill scale on iron. Those regarding it as having a protective effect, states Mr. W. R. Douglas Shaw in the *Automobile Engineer*, generally overlook the fact that its distribution over the surface is more or less accidental and far from uniform. Although electro-negative to iron, a perfectly uniform coating of mill scale distributed over the entire surface undoubtedly would exert a temporary protective influence, but in the uneven distribution in which it generally occurs, it is a powerful accelerator of corrosion, and promotes pitting in the presence of moisture and electrolytes. Surface finish is an important factor on which anti-corrosive properties are largely dependent, and the removal of mill scale is a practice deserving general application. The recognised pickling process for the removal of mill scale consists of immersing the metal in dilute sulphuric acid. Upon removal from the acid, the metal must be thoroughly scoured and soaked in caustic soda, in order that any traces of acid, retained in the pores, may be neutralised.

THE advantages of electric clocks, states a writer in the *Electrical Times*, have been very much overlooked by the majority of wiring contractors, and it is seldom that they bring these before their customers. Take any large public building in which a considerable number of clocks are essential, and it will be found that, from the point of view of actual cost, electric clocks will work out cheaper than ordinary clocks of good quality. The maintenance costs are decidedly less, and there is no question as to good time-keeping. In carrying out contracts for electric clocks the wiring itself should not be regarded as ordinary bell wiring. Taking account of the cost of the master clock and dials, the cost of the cable itself is a comparatively small item, and it should always be worth while to wire with high-grade cable in conduit, or, if surface work is employed, at least with lead-covered electric light cable of good quality. To wire clocks with bell wire is a mistake. It is true that the voltage between wires is very small indeed, but in wiring a public building for electric light or clocks the question of durability must be paramount, and easy replacement at least of second importance.

Miscellanea.

AT the last London meeting of the session of the Institution of Automobile Engineers, on May 9th, when Mr. A. W. Macaulay read a paper on ball bearings, a new procedure was adopted in the discussion in that the author replied to each speaker in turn, instead of waiting until the end of the debate. The experiment, which has been tried also before other centres of the Institution, proved to be a very great success, and will be adopted in the future.

WE are requested to remind our readers that the British Electrical and Allied Manufacturers' Association, Incorporated, grants annually, to properly qualified candidates of British birth engaged in engineering works, ten scholarships each of the value of £100, in addition to the payment of college fees. The last date for receipt of applications is June 1st. Forms and full particulars may be obtained by writing to the Secretary, the B.E.A.M.A., 36, Kingsway, London, W.C. 2.

THE United States Geological Survey has issued a report containing maps and descriptions of twenty-three sites along the Salmon River in Idaho at which, it is estimated, nearly 400,000 horse-power could be developed at times of low-water flow, and nearly twice that amount at times of medium flow. The project suggested for one of these sites contemplates the diversion of the flow of Salmon River into the Snake by means of a tunnel 8 miles long, which would create a head of 430ft. The report is based upon an extensive investigation made during 1921.

THE production of pig iron in April, says the National Federation of Iron and Steel Manufacturers, amounted to 652,200 tons, compared with 633,000 tons in March, and 394,300 tons in April, 1922. The furnaces in blast at the end of the month numbered 216, an increase of 14 during the month. The production includes 226,400 tons of hematite, 207,200 tons of basic, 144,700 tons of foundry, and 38,800 tons of forge pig iron. The output of steel ingots and castings in April amounted to 749,400 tons, compared with 802,500 tons in March, and 404,200 tons in April, 1922.

THE Auckland (N.Z.) Harbour Board has agreed to a recommendation by the harbourmaster that dredging work be undertaken on both sides of the new Prince's Wharf, and between the Prince's and Queen's Wharves, to provide a depth of 35ft. low water on spring tides. The work will entail the removal of 400,000 yards of material, and will take over two years to complete. The Harbour Board at Tauranga, 95 miles south-east of Auckland, has given its approval to certain harbour improvements, and has appointed a sub-committee to make inquiries with a view of ensuring a loan of £50,000 for the work.

IT was reported to the Newcastle-under-Lyme Town Council recently that the Electricity Committee had discussed a report by the borough electrical engineer relative to the desirability of an extension of the generating plant to meet the anticipated demand during next winter. The cost was estimated at £3000. It was resolved to instruct the engineer to obtain tenders for the installation of a 500 kilovolt-ampère converter set, with switchboard extensions, &c. The Council has agreed to this and to an application being made to the Electricity Commissioners for an Order continuing the power of the Corporation to charge up to a maximum price of 10d. per unit of electricity.

ONE of the most important features of the forthcoming International Mining Exhibition, at the Royal Agricultural Hall, will be the Safety in Mines exhibit, arranged by Professor R. V. Wheeler, D.Sc., Mines Department Experimental Station. The public will be shown the more important advances that have been made in the science of accident prevention in coal mines as a result of the experimental work that has been carried out in this country and abroad. Sir Philip Lloyd-Greame, President of the Board of Trade, will open the exhibition on June 1st. In addition to the Mines Department of the British Government, the French, Belgian, United States of America, Mexican, Rumanian and Colombian Governments are officially taking part in the exhibition.

THERE are indications of higher costs in the production of pig iron and ingot steel in Canada, says the *Iron and Coal Trades Review*. Lake ore prices are stated to have been established for the year at an advance of 50 cents, say 2s. 2d. a ton over 1922 prices. Another factor is the wage advance to both common and skilled labour, which became effective on April 1st. Large numbers of both common and skilled workers are leaving Canada for the United States, owing to the restriction of European immigration into the latter country, and to the demand for labour caused by the trade revival. Scarcity of steel is now the prospect confronting industrial works in Canada. While there are large tonnages on order, and warehouses have stocks sufficient to meet seasonable requirements, it is predicted that by July next the trade will be run on a hand-to-mouth basis. Price advances at the end of March included a rise of 1 dollar per ton on pig iron, to 36.55 dollars (154s.) at Toronto, and 38.90 dollars (164s.) at Montreal for best foundry grade.

THE Ontario Legislature, on April 30th, appropriated a total amount of 12,687,000 dollars, for the provincial hydro-electric power system, distributed among the different developments as follows:—Niagara system, 9,850,000 dollars; Muskoka system, 360,000 dollars; Rideau system, 20,000 dollars; Thunder Bay system, 1,015,000 dollars; Central system, 1,375,000 dollars; Nipissing system, 17,000 dollars; Essex system, 50,000 dollars. The sum of 50,000 dollars was also voted for an investigation by the engineers of the hydro-electric system on a second Queenston-Chippawa development with a view to the possibility of another canal. The Hon. Dougall Carmichael, in asking for the appropriation, stated that if the present facilities were used to capacity, the Hydro-Electric Commission estimated that it could only supply the demand until 1926 or 1927. The total amount of capital expenditure involved on the Queenston-Chippawa development up to October 21st, 1922, was 65,495,248 dollars, and in February last there was sold from the four units now in operation 180,584 horse-power. The total output of all the plants at Niagara is approximately 510,000 H.P.

POWER HOUSE OF THE BUENOS AIRES WESTERN AND BUENOS AIRES GREAT SOUTHERN RAILWAYS

(For description see page 517)

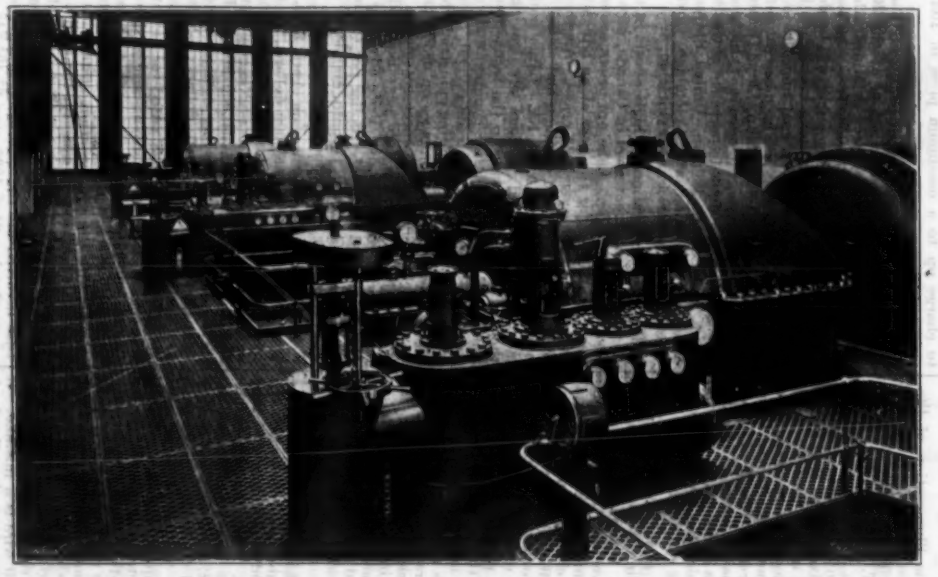

FIG. 7—TURBINE ROOM

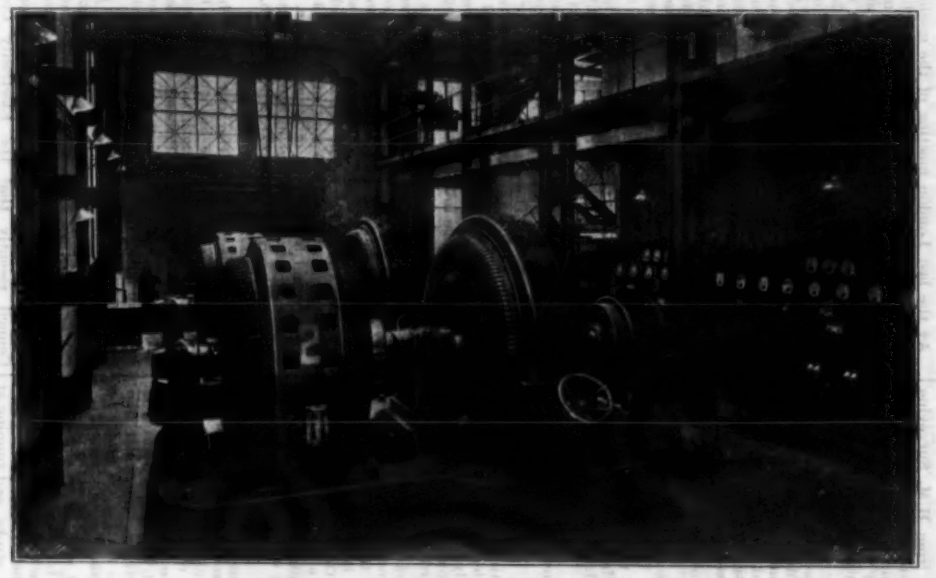

FIG. 8—FREQUENCY CHANGERS

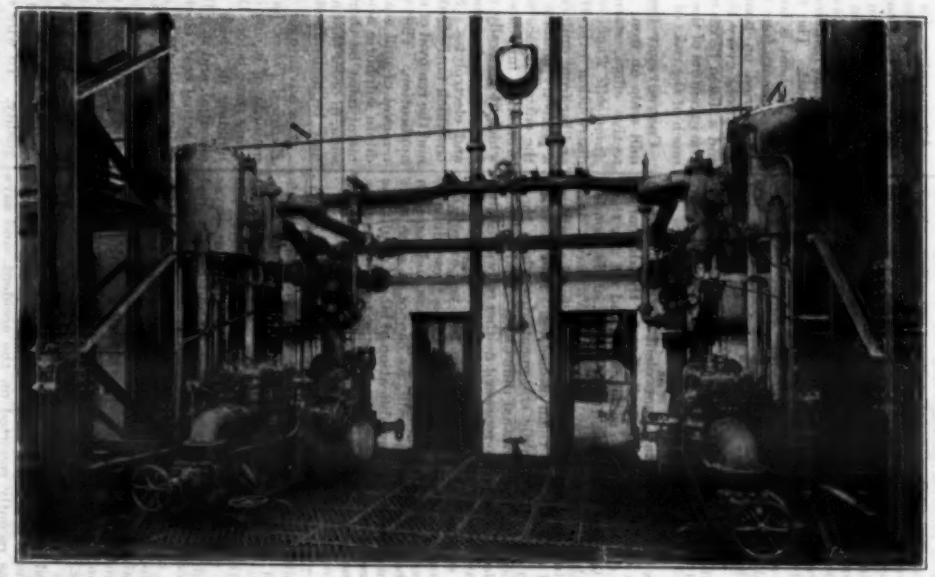

FIG. 9—THE PUMP ROOM

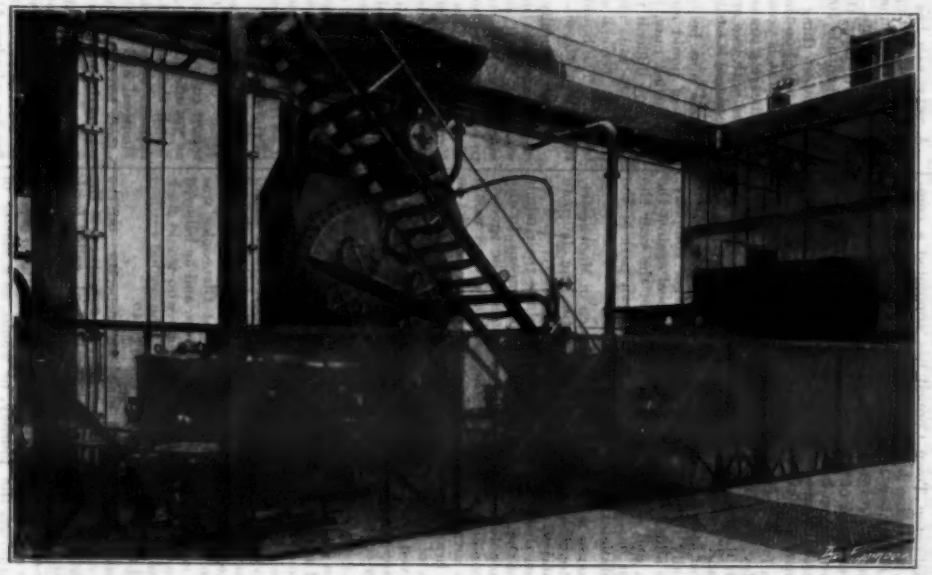

FIG. 10—ONE OF THE CONDENSERS

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PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two-page Plate illustrating a 60-Ton Self-propelling Drag-line Excavator. Every number as issued by the Publisher contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

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*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

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TWO-PAGE SUPPLEMENT—60-TON SELF-PROPELLING DRAG-LINE EXCAVATOR.

DEATH.

SUDDENLY, at Birling Gap, Eastbourne, on May 1st, HARRY LLEWELYN DAVIES, chairman of Cochran and Co. (Annan), Limited.

THE ENGINEER.

MAY 18, 1923.

The Helicopter Competition.

A STUDY of the conditions laid down by the Air Ministry for its £50,000 helicopter competition leaves one almost breathless with wonderment at the apparent faith, displayed by those responsible for drawing up the requirements, in the probable development of the helicopter during the next twelve months. Indeed, but for one fact, namely, that if the prizes or any of them are not won next year they are to be re-offered for competition during the ensuing twelve months, we might be tempted to come to the conclusion that the conditions have been made so stiff as deliberately to prohibit their fulfilment. Judged by the value of the prizes to be awarded, the qualities required of the helicopter by the Air Ministry are in ascending order of importance: first, ability to rise off the ground; secondly, ability to descend safely with the engine shut off; thirdly, ability to hover above a prescribed point; and fourthly, ability to maintain itself in the air at a given height and fly horizontally thereat over a stated distance at a prescribed speed. For the fulfilment of these tests the prizes to be awarded are respectively five, ten, fifteen, and twenty thousand pounds. These prizes are certainly generous, and as for the tests few will quarrel with their nature and the order of importance in which they are arranged, although some may criticise the omission of all reference to fuel consumption. When, however, we examine the numerical conditions attached to the requirements and compare them with the actual performances so far achieved with existing designs of helicopters, we are left with an impression—a wrong one, no doubt—that the competition, at least for the next year or two, is not meant to be taken very seriously. For the first test the Ministry requires that a competing machine with pilot, fuel for an hour, and 150 lb. of military load, shall, in a ground wind of between 10 and 20 miles an hour, ascend vertically to a height of 2000ft. and descend and land without damage. For the second test the machine is to be manœuvred over a given point and then to descend from a height of 500ft. with the engine shut off and alight within a hundred feet of the given position. For the third test it has to hover at 2000ft. for half an hour over a prescribed area, while for the fourth it has to fly at that altitude over a given closed circuit of not less than 20 miles at an air speed of 60 miles an hour or more.

Within the past fortnight MM. Oehmichen and Pescara, both of whom have been studying and experimenting with helicopters for several years, have established, in France, various records in the way of helicopter flight. M. Oehmichen, an early example of whose machine was illustrated and described in our issue of April 15th, 1921, succeeded in hovering for five minutes over one spot and just clear of the ground and in flying in a circle of 400ft. diameter. M. Pescara has described a circle of 130ft. diameter at a height varying from 20in. to 36in. above the ground, and has flown in a straight line a distance of 190ft. From America it is reported that the de Bothezat helicopter has left the ground with four persons on board, but for how long it remained up and how many inches it ascended to we are not told. These performances, compared with the Air Ministry's requirements, are as the first hops with the early power-driven aeroplane to the aeronautics of to-day. That there is the same probability of ultimate success is much more than doubtful, for the helicopter idea is at least as old as the aeroplane and is still in the embryo stage. Unless developments are proceeding of which we are in ignorance—in this connection it may be said that Mr. Louis Brennan's helicopter, constructed with great secrecy at Farnborough, is by a special clause in the conditions expressly excluded from the competition—it seems quite unreasonable to expect that by April next year the Ministry will receive any entries of machines having prospects of being able to satisfy the required conditions. Although the theory of helicopter flight has now been fairly well established, the practical and constructional difficulties in the way of giving it effect are enormous. If the assistance of fixed supporting plane surfaces is dispensed with, the problem of heavier-than-air flight is reduced to the basis of that set himself by a man who chooses to carry a load of earth in a bag over his shoulder instead of transporting it in a wheelbarrow. In an aeroplane the net thrust developed at the propeller may be taken as approximately one-tenth of the total weight of the machine when the speed is 60 miles an hour, and as about one-quarter at 100 miles. In the case of a helicopter, however, the sustaining screws must at all times develop a net thrust equal to the total weight of the machine, and, in addition, they or other screws must be capable of developing the extra thrust required for horizontal flight. The first practical difficulty encountered is therefore that involved in having to use an engine of much higher power and greater weight than is necessary in an aeroplane developing the same lift. This penalty is inherent in the very principle of the helicopter and cannot be avoided. A less fundamental difficulty, yet one which so far has given perhaps chief trouble in the practical design of helicopters, is the devising of a satisfactory method of transmitting the power from the engine to the sustaining screws. It is obvious that unless one large central screw is used—an idea which has now been practically abandoned—all the complications of the power system in a multiple-screw aeroplane, complications which are only now being satisfactorily solved, have to be faced in the helicopter from the very start. On this score it is perhaps worth noting that while the helicopter clearly calls for an engine especially designed for itself and differing radically from the present highly developed aeroplane engine, no such power plant is to-day commercially available, nor it may be supposed will one be produced until the helicopter has definitely established its position as a practical and desirable means of flight. The helicopter designer has thus for the present either to adopt a makeshift type of engine or face the formidable task of designing and constructing an appropriate one for himself. The problems of securing horizontal flight without propellers other than those used for sustentation and of regulating the speed of descent when the engine is shut off are too big to be more than mentioned here. It is sufficient to say that while they are theoretically capable of solution, the steps taken towards their practical realisation so far as they have been disclosed do not up to the present afford much ground for believing that within a year it will be possible to fly horizontally at 60 miles an hour or to descend safely, with the engine shut off, from a height of 500ft. If, on the other hand, reliance is placed on separate propellers for horizontal movement and on the regulation of descent by the application of power to the sustaining screws, there will be, on the one hand, a great increase in the complications of the power drive, and, on the other, a risk of immediate disaster in the event of engine failure. These remarks, of course, apply to the helicopter of the pure type. While the Air Ministry's conditions definitely exclude the entry of a machine deriving its sustentation or any part of it from gaseous buoyancy,

they permit, it seems clear, the entry of a machine fitted with aerofoils. The latter type of helicopter has attracted the attention of many inventors, but has met with no success, for the obvious reason that until the machine develops horizontal velocity of a considerable amount the aerofoils contribute nothing at all to the lift and represent only so much added dead weight and increased resistance during the period of ascent.

The Air Ministry, in drawing up the conditions of its competition, is, we feel certain, looking very much ahead, to say the least of it. As ideals to be worked towards, its requirements could hardly be improved upon, but as attainments to be realised in the near future they seem hopelessly ambitious. Whether, as ideals or possible attainments, it is worth while striving to realise them, is an aspect of the matter on which various opinions will no doubt be expressed. From the civilian point of view the flying machine which can get off vertically and alight on a confined area represented by a circle of 100ft. radius would no doubt prove attractive, although it should be noticed that aeroplanes are already existent which, when alighting, can pull up in still air after a run of less than 200ft., while with a little assistance from the wind, machines such as the Handley Page slotted wing type can rise in a path which is as nearly vertical as is necessary for most practical situations. It is not, however, from the civilian point of view, so at least we prefer to hope, that the Air Ministry is seeking to encourage the development of the helicopter. Yet from the military aspect no clear and authoritative statement as to the advantages possessed by this class of machine has, so far as we know, ever been made. As a substitute for the observation balloon it would no doubt find an opportunity for the useful exercise of its ability to hover. Its ability to rise and descend vertically would also be of service for deck landing in the Navy, provided the difficult problem of controlling it in a wind were solved. It is, however, open to argument whether existing types of deck-landing aeroplanes, operated, as they are, in close conjunction with the velocity of the wind and the speed of the vessel, are not already capable of doing all and more than all that could be expected of the helicopter when perfected. As for fighting purposes, the special properties of the helicopter would in most circumstances place it at the mercy of an enemy aeroplane rather than give it any advantage, while for bombing its ability to hover would, if it were permitted to exercise it, no doubt be very greatly appreciated by the enemy's anti-aircraft gunners. One well-known maker of aeroplanes has personally told us that to construct a helicopter for the competition would involve a greater expenditure of money than he would receive if he won all four prizes. We can well believe it and on all counts we share his view that the sum available could be far more usefully applied in the encouragement of orthodox aeroplane research and in rendering assistance to the hard-pressed aircraft industry than in promoting a competition of the nature indicated.

The Kelvin Lecture.

THERE is no electrical lecturer, as far as we know, who can cover so much difficult ground in a short space of time as Dr. J. A. Fleming. Given the signal to begin, he plunges into his subject without tiresome and unnecessary historical references, and continues with extraordinary rapidity until the end. His lectures comprise a torrent of words, a rapid display of pictures and diagrams on the screen, copious blackboard work, and often some extremely good experiments. Those who listened to his lecture on the work of Faraday at the opening of the Institution of Electrical Engineers' commemoration meetings last year must, we feel sure, have been greatly impressed by that remarkable performance. Every experiment that was shown proved a complete success, notwithstanding that some of them were of a delicate nature and might easily have been a failure in less skilled hands. His Kelvin lecture, delivered at the headquarters of the Institution of Electrical Engineers on Thursday evening of last week, on "Problems in Telephony, Solved and Unsolved," was equally good, although less attractive from an experimental point of view.

To consider all the matters which Dr. Fleming touched upon is out of the question, for, beginning with Graham Bell's telephone, he passed speedily on to many branches of the subject, finally reaching modern developments, such as carrier-wave or wired-wireless telephony, the use of the thermionic valve as a telephone relay repeater, the development of high-power transmitting valves, the principles of electric filters, and so on. When printed in the Institution's *Journal*, the lecture will unquestionably be studied by many engineers who are connected with or who are interested in telephony. There was much in the lecture which could be followed with perfect ease and which called for little, if any, electrical knowledge. The energy necessary, it was shown, to excite a sensation of sound in the human ear is extremely small in comparison with what many may suppose it to be. Experiments in this connection were carried out in 1877 by the late Lord Rayleigh, who found that a whistle giving out a sound or air wave having a frequency of 2730 could be heard on a calm day by a normal ear at a distance of 820 m. From the power required to blow the whistle Lord Rayleigh estimated that the amplitude of motion of the air particles in the sound wave at the distance mentioned was only .8 of one-millionth of a millimetre, or less than twenty-five millionths of an inch. The fact that the human ear can detect the extremely slight changes in the air pressure due to this motion shows that after all the human ear is by far the most sensitive piece of mechanism which is brought into play during an ordinary telephonic conversation, but nevertheless, without the ingenuity of Oliver Heaviside, Dr. Fleming and others, telephony at the present time would, relatively speaking, be in a very backward state. As the lecturer explained and as others have shown in papers read before the Institution of Electrical Engineers, the thermionic valve is of great value in ordinary long-distance telephony, as well as in wireless work, for it increases the telephonic range and makes possible the use of finer wire or underground cables. Technical difficulties associated with long-distance land telephony have for all intents and purposes been overcome, whilst for communication across oceans the radio system seems to offer strong possibilities. Of course, before the introduction of the thermionic valve the loading or the deliberate addition of inductance to the circuit, as suggested in 1887 by Oliver Heaviside, was a great step forward in the direction of increasing the distance of speech transmission, and Heaviside's work should never be overlooked. Of modern improvements in telephony, the carrier system, as dealt with some time back in our columns and in the lecture, is one of the most remarkable and most useful from the point of view of increasing the capacity of telephone and telegraph circuits. On the so-called weak current side of electrical engineering progress has indeed been marvellous, but knotty problems remain to be solved. In wireless work the three principal unsolved problems to which Dr. Fleming referred were those associated with "atmospherics," "blind spots," and "fading." Many patents have been taken out for schemes designed to eliminate the effects atmospherics, but up to the present none of them appear to be very successful. The causes of "blind spots" and "fading" are at present very imperfectly understood. It is gratifying to find, however, that the Radio Research Board is now about to investigate these matters. Owners of receiving sets are invited to co-operate in the work, and it is to be hoped that all amateurs in a position to do so will give the Research Board all the assistance they can. The most interesting branch of electrical work at the present time is undoubtedly that which the fourteenth Kelvin lecture covered. Heavy electrical engineering seems to have come more or less to a standstill so far as really new ideas are concerned, but this lighter branch of electrical work opens up unlimited scope for investigation. Any serious experimenter in wireless telephony soon finds that there are innumerable circuits, &c., that may be tested, and that very many hours may be spent on really interesting and profitable tasks. The next few years are almost bound to bring new and important developments to light. Marked progress in the construction of large transmitting valves for large wireless stations is practically certain to be witnessed. In seconding the vote of thanks to Dr. Fleming last Thursday evening, Dr. Eccles referred to a 1000-kilowatt valve which he had seen in the laboratories of the General Electric Company of America, a valve which could be taken to pieces with the aid of spanners and which had a filament resembling an iron poker. These remarks about this large valve arose out of the last part of the lecture, where Dr. Fleming emphasised the need for research and illustrated on the screen the enormous research laboratories of the American General Electric and Western Electric companies. There is nothing to equal these laboratories in this country, although, of course, a notable advance has been made by the recent opening of the General Electric Company's establishment at Wembley.

No country that claims to be progressive can afford in these days to ignore the importance of thorough scientific investigation, particularly in connection with the class of work covered by Dr. Fleming's lecture. In the past this country has contributed in no mean degree to science and engineering, and no better proof of this could be provided than the fact that on the occasion of this lecture the Faraday medal, which constitutes the highest honour the Institution can confer upon an engineer for distinguished work, was presented to Sir Charles Parsons, the man who, as Mr. J. S. Highfield said, has made possible the great progress that has been witnessed in heavy electrical engineering. Sir Charles Parsons' work, like that of other famous British engineers, has, of course, been of immense value in many parts of the world. The huge electrical schemes which have been put into operation would have been impracticable without the turbine, and this country can therefore still claim to hold its own in heavy engineering. That, however, should not cause us to become indifferent to what may appear to some to be of less importance, namely, research in the lighter branches of the industry. Looking back on past achievements in this field, it is seen how quickly one discovery may lead to another and very soon benefit the community at large. Little did anyone imagine, when the original two-electrode detector valve was introduced in 1904, that the electron emission principle would be used not many years later for amplification and transmission, and that in this way it would become possible for millions of people to sit in their homes and listen to speech and music transmitted from wireless stations miles away. This in itself is surely sufficient, if personal feelings about broadcasting are set aside, to show the desirability of research on a scale comparable, to some extent at any rate, with that carried out abroad. There are just as good electrical brains in this country as there are anywhere else, but unless there are adequate facilities for investigation we cannot hope in these days to keep abreast with others.

Iron and Steel Institute.

No. I.

THE annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, May 10th and 11th, Mr. Francis A. E. Samuelson, President, occupying the chair.

The first business was the presentation of the report of the Council, from which the following particulars have been abstracted:—

During the year under review eighty-four new members and nine associates were elected, and nine associates were transferred to membership, the total membership on the register of the Institute on December 31st, 1922, being made up as follows:—Patron, 1; honorary members, 6; life members, 80; ordinary members, 2113; associates, 37; total, 2237.

The deaths of twenty-four members were reported to the Council during the year and the deaths of six members which occurred prior to 1922, but were not reported to the Council until that year were recorded.

The Council desires sincerely to express its sense of the loss of the Institute's esteemed honorary member, Dr. Richard Akerman, Bessemer Medallist, and a member of the Institute for over forty-seven years; and of Dr. Henry Marion Howe, honorary vice-president, to whom the Bessemer Medal had similarly been awarded in 1895. By the deaths of Professor McWilliam, Mr. J. T. Middleton, and Professor Hubert the Institute has likewise been deprived of the loyal support those members had for many years afforded it. The income for the year under review was £7964, exclusive of the Carnegie Scholarship Fund. The expenditure was £7939.

BESSEMER MEDAL.

The Bessemer Gold Medal for the year 1922 was awarded by the Council to Professor Kotaro Honda (Sendai, Japan) for his distinguished services to the advancement of the metallurgy of iron and steel.

ANDREW CARNEGIE RESEARCH SCHOLARSHIPS.

Grants were made by the Council, on the recommendation of the Carnegie Scholarship Committee, to the following candidates:

A. Bramley (£100), for investigations on the carburising and decarburising effects of different gases on iron and steel.

A. L. Curtis (£100), for investigations on steel moulding sands and their behaviour under high temperatures.

O. W. Ellis (£100), for investigations on the effect of constitution on malleability at high temperatures.

J. N. Friend (£100), for researches on corrosion.

E. M. Parkin (£100), for investigations on the influence of heat treatment and variable carbon content upon magnet steel of constant tungsten composition.

G. V. Phragmén (£100), for investigations on the specific weight of molten metals.

W. E. Williams (£100), for investigations on X-ray spectrography as applied to examining the structure of steel.

The President said that the next item on the agenda was the presentation of the Bessemer Gold Medal to Dr. Maw. The recipient was well known to all those present. Dr. Maw was born at Scarborough on December 6th, 1838. He was educated privately, and in 1855 he became pupil of the Eastern Counties Railway Works, now the Great Eastern Works, at Stratford, under the late Mr. John Gooch. In 1859

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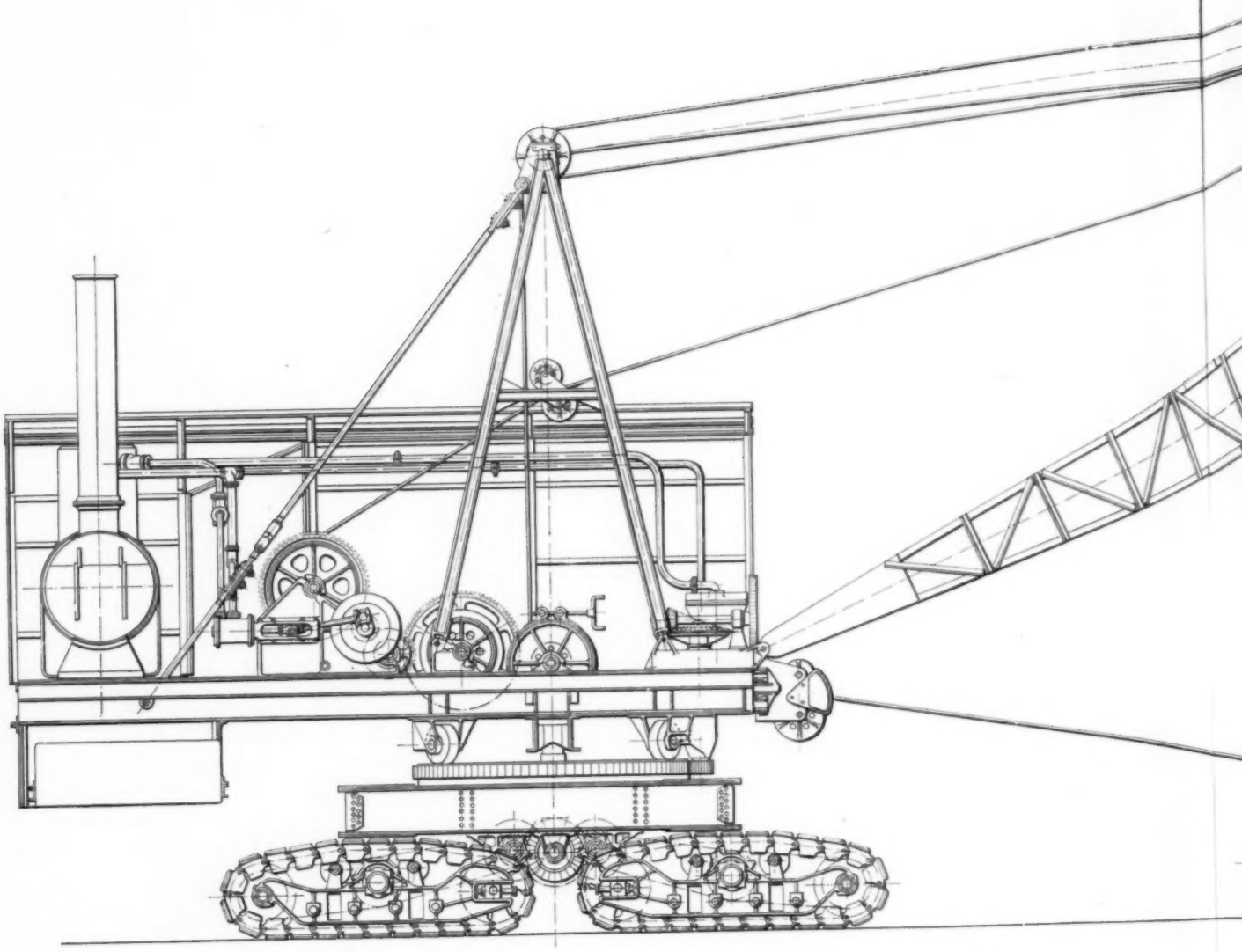

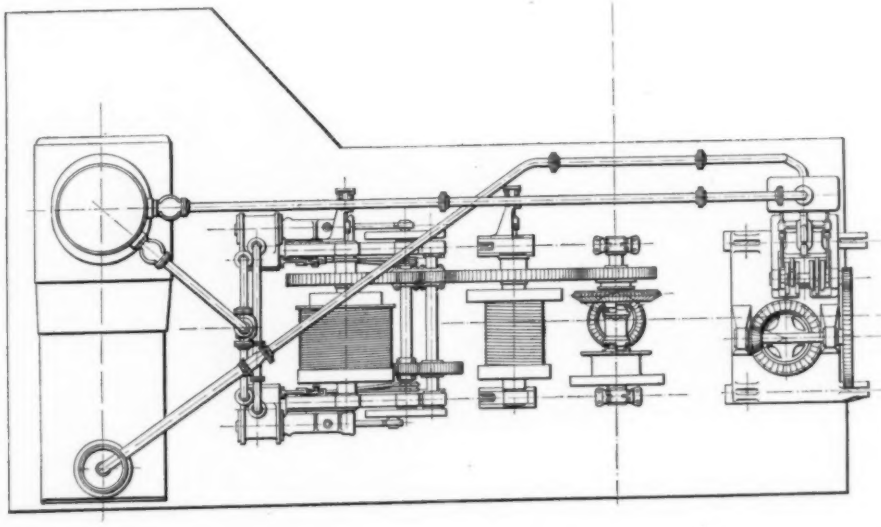

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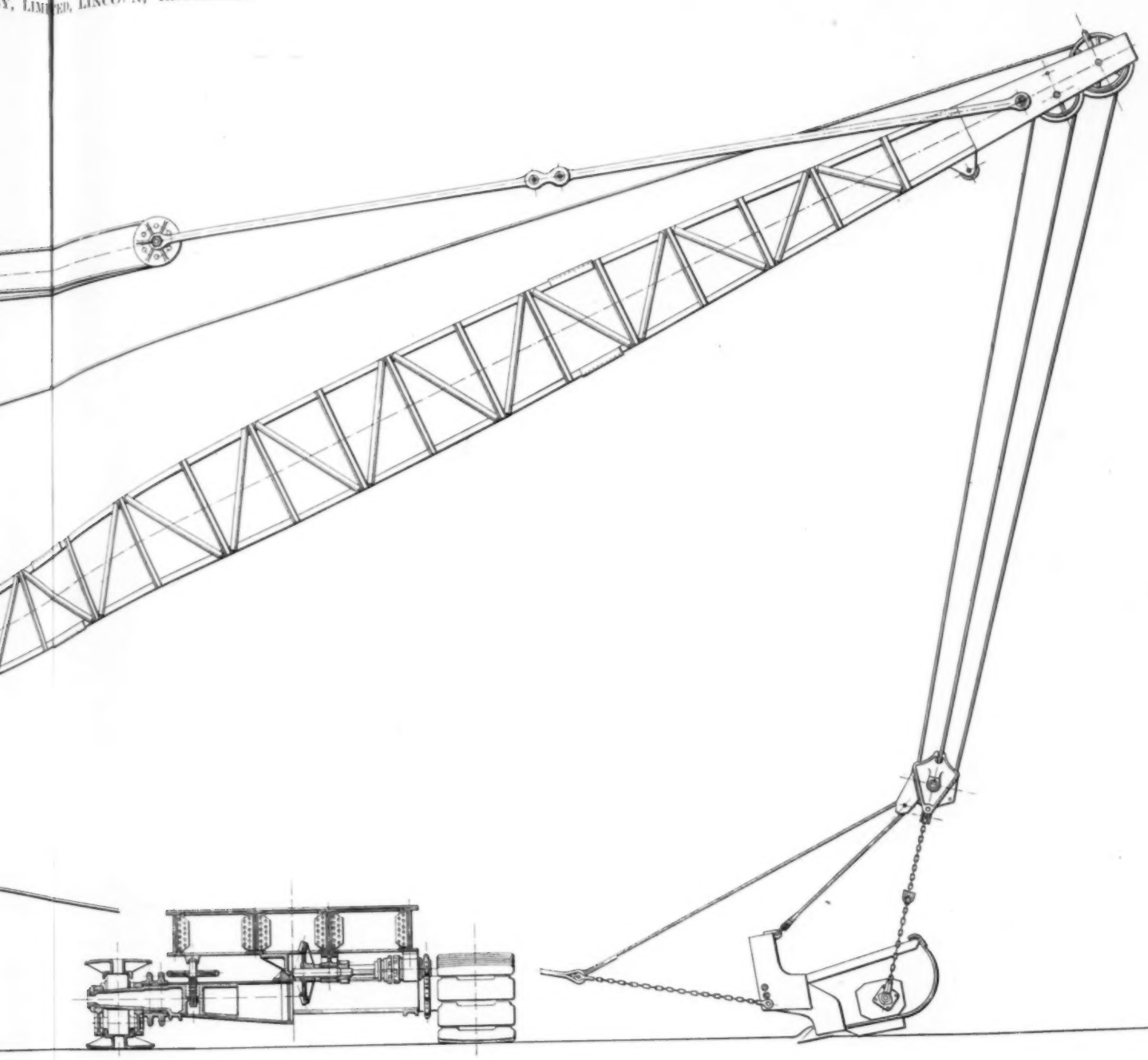
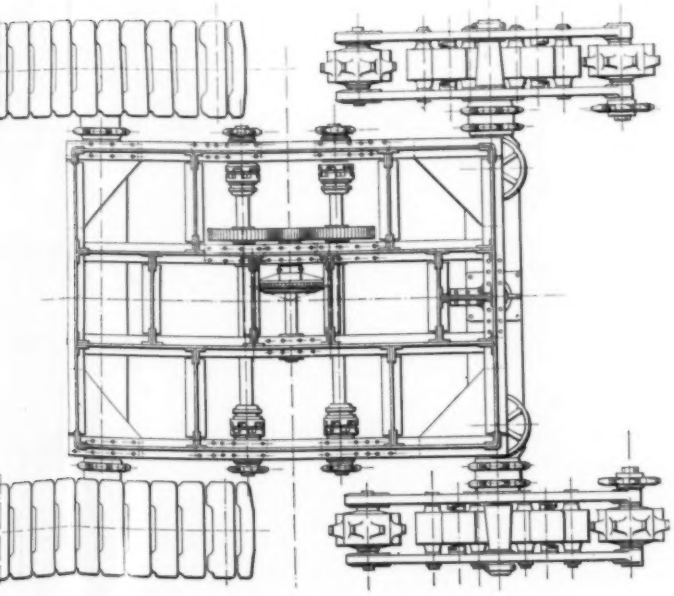




SWAIN SC

he became head draughtsman in the locomotive and engineering department at the Stratford Works, and in the following year he was attached to the private staff of Mr. Robert Sinclair—successor to Mr. John Gooch. In that capacity it fell to him to design locomotives for the Great Luxemburg Railway and for the East Indian Railway, those for the latter being the first outside cylinder engines placed on the Indian railways. In 1865 Dr. Maw left the Great Eastern Railway to join the late Mr. Zerah Colburn in the establishment of *Engineering*. The association of those two had begun in 1862, when there was an exhibition in London, and they collaborated in describing the locomotives exhibited. On the occasion of a visit to the exhibition in that connection Dr. Maw first made the acquaintance of Sir Henry Bessemer, who was closely identified with *Engineering*. Early in 1870 Mr. Colburn ceased his connection with *Engineering*, and Dr. Maw was joined in the Editorship by the late Mr. James Dredge, and the paper was carried on under their joint Editorship until the death of Mr. Dredge in 1906. Dr. Maw had done a great work for the advancement of engineering practice. From 1870 until within a few years ago, he had an independent practice as a consulting engineer, his chief work being in connection with engine and boiler construction, the design and arrangement of workshops and similar buildings. He was also consulting engineer for several important firms, and one particular phase of his work was the fitting of printing machinery for some of the great daily newspapers in England. As regards his literary achievements, in addition to many addresses and papers read before various engineering institutions, Dr. Maw was joint author of "The Waterworks of London" and of "Road and River Bridges," while "Recent Practice in Marine Engineering" long remained a standard record of developments in that department of science. He was one of the founders and Presidents of the Civil and Mechanical Engineers' Society. Perhaps the Institution which had profited most by Dr. Maw's work had been the Institution of Mechanical Engineers, of which he was President in 1901 and 1902. He was chairman of the International Engineering Congress at Glasgow University in 1901. His great experience and practical knowledge of engineering, and particularly of experimental work, made it natural that he should become a member of various Research Committees formed by the Institution to carry out work which had been invaluable to the whole profession, amongst others the Marine Engine Trials Committee, and the Gas Engine and Steam Jacket and Friction of Gears Committee. He joined the Institution of Civil Engineers in 1896, and in 1903 he delivered the James Forrest lecture. In 1911 he was elected a Member of Council, Vice-president in 1918 and President in 1922. Dr. Maw was elected a Member of the General Committee of the National Physical Laboratory, and was appointed to serve on the Executive Committee in 1905. For the British Engineering Standards Association he had done remarkable work. He was a member of the committee responsible for the foundation of the Association, and still continued to be a member of or chairman of most of the principal committees of that body. During the war he was a member of the Advisory Panel of the Munitions Inventions Department, and later he was chairman of the committee dealing with machine tools and mechanical transport. He also served on the committee appointed to consider the simplification of the manufacture of artificial limbs. He was a member of the Ophthalmic Hospital for many years, and afterwards President of the Institution. Dr. Maw was almost as well known for his work in astronomy as well as for that in engineering. Both at his town and country residences he had observatories in which he had spent many hours, and the one at Outwood was entirely built by local labour from drawings and templets made by himself. He was elected a member of the Royal Astronomical Society in 1888, and in 1892 became a member of the Council. In 1900 he was elected treasurer, and became President in 1905. During this period he delivered two Presidential addresses on "The Solar Spectroscopy and the Measurement of Motion of Stars in the Line of Sight" and "Researches in the Lunar Theory." In 1890 he was one of the founders of the British Astronomical Association, which had for its special object the encouragement of amateurs to carry out work of real astronomical value. Dr. Maw contributed to the work of the section devoted to the observation of the moon, of Jupiter, Mars and Saturn respectively. He became Vice-president and subsequently held the office of President from 1899 to 1901. His most notable original research in astronomy was connected with double star observations, on which he contributed papers to the Royal Astronomical Society. Dr. Maw was elected a Fellow of the Royal Geographical Society in 1890, and of the Royal Microscopical Society in 1892. He was also a member of the Board of Studies of the University of London, and in that connection it might be mentioned that, in 1909, the University of Glasgow conferred on him the degree of LL.D. In presenting him to the Vice-Chancellor for that degree, Professor Smart, after briefly reviewing Dr. Maw's work, said "It is fitting that our University, situated in what has not inaptly been termed the metropolis of mechanical engineering, should recognise the great services which Dr. Maw has rendered to the advancement, both of pure and applied science, by admitting him to its roll of honour." He had very great pleasure in making the presentation to Dr. Maw of the Bessemer Gold Medal which, as the members knew, was the highest honour the Institute had it in its power to confer.

Dr. W. H. Maw, in a brief response, said the award had an additional value to him from the way in which it connected him with Sir Henry Bessemer, with whom he had a friendship which, he was glad to say, lasted up to the time of Sir Henry's death. He tendered to the President, to the Council and the members his most sincere thanks for the honour that had been conferred upon him.

A paper entitled "The Re-activity of Coke as a Factor in the Fuel Economy of the Blast-furnace," by Messrs. E. R. Sutcliffe and Edgar C. Evans, with a note by R. V. Wheeler, was then read. It is given in abstract below:—

COKE.

The following notes deal with the blast-furnace, not as a glorified gas producer, but in its primary function as an apparatus for the reduction of iron ore. Apparently the general tendency in modern plants is to secure the highest possible economy in the blast-furnace operations and to install supplementary plant for additional heat requirements. In the case of new plant this seems the logical method of procedure, if only for the reason that the blast-furnace is such an expensive gas producer that the cost of production per B.Th.U. of gaseous fuel produced would probably be considerably higher than that produced in plant specially designed for the purpose.

Theoretically, if pure iron ore could be reduced in accordance with the equation—

$$Fe_2O_3 + 3CO = Fe + 3CO_2,$$

the total carbon requirements would only amount to 6¼ cwt. per ton of pig iron, whilst the chemical and thermal requirements can be satisfied—for pure ore—with an expenditure of only 8.6 cwt. of carbon per ton of pig iron. When it comes to specific suggestions as to how this can be effected, so many factors are involved that it is extremely difficult to cover them even in a general way. This is especially true where the question is dealt with by investigators who are not engaged in the industry itself.

The influences which determine an increase in the carbon dioxide percentage in blast-furnace gas are blast-furnace design and the character of the materials used. The materials entering the blast-furnace consists of (1) ore, (2) limestone, (3) blast, (4) coke. It is with the last named that this paper is mainly concerned.

The essentials of a blast-furnace coke are:—(1) Freedom from ash and sulphur; (2) high carbon content; (3) resistance to the action of CO_2 in the upper region of the furnace; (4) rapidity of combustion; to secure this the size of the coke lumps must not be too great; (5) uniformity of size, a maximum size of 4in. to 6in. and, on the other hand, freedom from smalls; (6) strength without "density," as "density" is inimical to rapid combustion and fast driving; (7) porosity—or highly developed cellular structure—which, however, must not be so open as to reduce strength, with the subsequent production of smalls; (8) hardness, to resist abrasion in the furnace.

There is hardly any quality in coke which has been more strongly condemned than that of its solubility in carbon dioxide; but the solubility of a coke is in itself a measure of its combustibility, and combustibility is the most important property in a coke.

The authors have worked upon this question from a rather novel standpoint. They found that the combustibility of a carbonised fuel is primarily dependent not so much on the percentage of volatile matter it contains as upon its structure. Provided care be taken to obtain a certain characteristic structure in the resulting product, a coal can be carbonised at practically any temperature, in practically any type of carbonising system, and still retain an extremely high degree of combustibility.

The factors involved in the production of this structure can be summarised as follows:—

(A) Preparation of the coal prior to carbonisation:

(1) Efficient cleaning.
(2) Preliminary treatment or blending of coals or coke to ensure a minimum of swelling in the retort.
(3) Fine grinding of the coal.
(4) Briquetting of finely divided coal mixture.

(B) Carbonisation of the coal as slowly as possible consistent with economic requirements.

The characteristics of the structure of the resulting fuel can be summarised as follows:—(1) Extensive area of surface per unit of mass; (2) high porosity; (3) minute size of cells; (4) pronounced porosity of cell walls; (5) greater degree of continuity of cell structure than is the case with ordinary blast-furnace coke.

The whole subject, from a theoretical standpoint, is extremely fascinating, and opens up a field of immense possibilities, not only in the fuel and iron and steel industries, but in practically every sphere of chemical and metallurgical practice. For the moment, however, all that it is necessary to say is that by suitable methods of treatment a fuel can be obtained of hardness equal to that of metallurgical coke, of density approaching that of coal, and with a combustibility or "reactivity" of the order of that of charcoal.

The following particulars of such a fuel may be of interest:—

Analysis of "Pure Coal Briquette" Coke.

	Per cent.
Ash	8.0
Volatile matter	0.75
Apparent specific gravity	1.20
True specific gravity	1.80
Volume of cells	33.3

These results show that a material prepared in the manner outlined possesses the properties both of coke and charcoal (differing, however, in the very high apparent specific gravity that it possesses). The authors venture to believe that the use of a fuel of this character will allow of considerable economies being effected in the fuel consumption of blast-furnaces.

This view, of course, is based as yet purely upon theoretical considerations, and, pending a large-scale trial, it is impossible to say how far they are correct or not.

Mr. David Brownlee dealt with the paper from the national point of view. In this country two problems had to be solved. The first was fuel economy, and the second was agriculture. Without wishing to appear melodramatic, if those two problems were not solved the country would go under. The iron and steel industry was associated very closely with the question of fuel economy and problems connected with coal. He thought that about 260,000,000 tons of coal per annum were raised in this country, of which about 190,900,000 tons were burnt at home. Of that quantity only some 30,000,000 tons were consumed in the direct form, and the valuable by-products—ammonia, petrol and so on—were practically wasted. Those engaged in the iron and steel industry were among the offenders. They squandered in two ways; by wasting blast-furnace gas and by wasting coke-oven gas in the making of coke. The paper showed that it was not necessary to have a large volatile content in order to make a fuel combustible, but that with as little as 1 per cent. of volatile matter the fuel could be used to advantage. This fuel had also a very high reactivity, and it was that very high reactivity which led the authors, and rightly so, to believe that they would get with their fuel in the blast-furnace the same high quality of pig iron as that originally obtained with the old charcoal apparatus. In his opinion the iron and steel industry would be well advised to try the process as soon as possible.

Mr. W. J. Foster said that the authors referred to the quantity of blast which gasified the carbon at the tuyeres as being the measure of fuel economy. Mr. Johnson contended that the greater the blast that entered the tuyeres and the more carbon monoxide which was made from the carbon, the greater the efficiency and the smaller the quantity of coke which was necessarily required. He (the speaker) had proved that statement to be far from true; the reverse, in fact, was rather the case. In blast-furnace practice to-day, as in the past, the management should aim at gasifying as little as possible at the tuyeres in proportion to the amount of iron made. He would also like to draw particular attention to the statement made by the authors regarding his own attempt to ascertain the efficiency of blast-furnaces. In this particular case, the question was whether the gases in charcoal had any effect on the efficiency of coke or charcoal in a furnace by protecting the oxidation or, as the authors called it, the solubility; that was to say, the action of CO_2 on solid carbon. He contended that the gases eliminated from charcoal, which amounted in ordinary commercial charcoal from 175 to 171 volumes, constituted a great saving and protected the action of solubility. Those gases usually included ammonia, which contained hydrogen and nitrogen. Nitrogen, being inert, did not affect the situation so much. But the hydrogen, leaving the charcoal at a temperature of somewhere about 400 deg. Cent., had a reducing action on oxide of iron. The result was that the oxides of iron introduced into the charcoal furnace were usually very rich and easily reduced at a temperature of about 200 deg. Cent. Nascent hydrogen eliminated from the charcoal often took up oxygen immediately and went away as steam or water. Further, it must be clearly understood that charcoal produced very little ash and that in the form of alkali, particularly potassium. Potassium melted at a very low temperature. Long before the potassium reached the bosh of the furnace it melted, and in that way protected the fibre of the carbon to a certain extent by saturation, as it were. On the other hand, coke contained alumina and silica, either of which might be in excess and both of which were infusible, or practically so until they reached the hearth of the bosh, with the result that there was probably 12 per cent. of that material which accumulated in masses of soft or hard coke in the ash which rested on the bosh and hearth. After a certain period the furnace assumed the form of a channel and the area of the bosh and hearth was reduced as well as the amount of efficiency of the furnace. That was not the case with charcoal. Therefore, there was no comparison in that respect between charcoal and coke.

Mr. A. K. Reese said that it was impossible to discuss in detail in the time available the arguments presented by the authors. He questioned, moreover, whether any end would be served by doing so, because it would be really an academic discussion of a theory which was opposed to all preconceived theories and was not based, he thought, on any ascertained facts. A comparison was made between the charcoal furnace and the coke furnace, or rather between charcoal in a charcoal furnace and coke in a coke furnace. He was not quite sure whether the authors meant to imply that the conclusions they had drawn from their reading of the action of charcoal in a charcoal furnace would apply to the action of coke or charcoal in a coke furnace; that was to say, a modern coke furnace. If that was the authors' view, he thought their conclusions were not justified. The two things were very different in many respects. The object of the paper apparently was to bring out the idea that the solution of carbon in a furnace was a beneficial reaction, and that direct reduction was also a beneficial reaction. They all knew that under modern blast-furnace conditions those reactions must necessarily occur, and the question was whether measures should be taken to increase those reactions with the object, as the authors suggested, of obtaining greater economy, or to decrease them. All existing evidence went to show that a reduction of those reactions would increase the fuel consumption. He hoped the authors would succeed in inducing ironmasters to make a practical test of their theory. With regard to direct reduction, if that were an economical reaction, it certainly should be the object of every blast-furnace operator to bring his ore and coke into intimate contact as early as possible in its passage through the furnace, because it was only by direct contact that reduction of solid carbon could possibly take place naturally. As a matter

of fact, the almost universal method of charging a blast-furnace was to charge it with the coke in layers of varying thickness and the ore in layers. That tended to reduce the direct contact of the coke and ore in the upper or reducing regions of the furnace, and had an opposite effect to that which the authors stated to be desirable. He hoped the authors would be able to substantiate their claims, because, if they did so, the advantage to the iron and steel industry would be tremendous. But he thought they ought not to talk about their theory very much until they had carried out a practical demonstration and proved it to be correct.

Mr. Alfred Hutchinson referred to the attempts made by himself and others to obtain a thoroughly clean coking coal by means of the froth flotation method, and so far as the cleanliness of the coal went that was quite sufficient. They had, however, been up against the difficulty of efficiently drying the coal, which was so thoroughly wetted in the mineral separation process. They had worked for some time along the lines of hydraulically pressing the purified coal to produce a kind of briquette. From the point of view of the briquette industry, that had been very successful; but they were not satisfied whether it would pay to install a plant for coking the coal by means of which it could all be briquetted and then transferred to the coke oven. However, if the saving was anything like that suggested by the authors, it would pay them to install a plant to carry out the process on a commercial scale.

Mr. Fred Clements said that he had just visited an experimental plant of considerable capacity in which iron had been made at an expenditure of 900 lb. of bituminous coal. That figure corresponded pretty closely to the theoretical figure put forward by the authors in their paper, namely, 8½ cwt. It was done partly by direct reduction and partly by indirect reduction, and the CO_2 content was far lower than anything previously obtained. The secret of the low consumption lay in the fact that the slack material had been removed by an altogether different process. It seemed to him that what had been done in that case gave considerable support to the theory put forward in the paper. It was no doubt somewhat dangerous to deduce what would happen in a coke furnace from what happened in a charcoal furnace, and he agreed entirely with Mr. Reese's suggestion that the only way in which the authors' proposition could be tested was in actual practice.

Mr. V. B. Reichwald said he had had in mind for some time past the making of Cleveland iron on a 12-cwt. basis. The suggestion now made was that the subject was allied to the question of cleaning the material, but the problem, as he looked at it, was to get a low consumption with such materials as were actually available. He agreed with the point made by the authors as to the extreme sensitiveness of the hearth, which, of course, would account to some extent for the economies realised by using a more rapidly combustible coke. The real crux of the whole thing was, however, a practical trial.

Mr. E. R. Sutcliffe said that the matter had occupied the attention of Mr. Evans and himself for many years. Now they were in want of funds in order to get the thing going and to turn out those fuels on a substantial scale so that practical blast-furnace tests could be made. They were at present arranging for an installation which would produce something like 300 tons a day. The cost of the plant would be about £120,000, and when that plant was really going it would be possible to carry out the tests which were so very desirable in order to prove or disprove their theories.

A paper by Mr. Fred Clements, on "British Steel Works Gas-producer Practice," was then presented by the author.

GAS PRODUCERS IN STEEL WORKS.

The value of this paper lies in its extensive tables. At the annual meeting of the Institute in 1922 the author had the privilege of reading a paper entitled "British Siemens Furnace Practice," and in that work he had confined himself to a study of the furnace only, taking the producer gas as delivered at the furnace regulating valve as the basis of heat supplied. Naturally, an investigation into gas producer practice was necessary in order to complete the previous work. Such a survey is therefore the purpose of the present paper, with the object of elucidating how closely it is possible to approach, in the commercial operation of a steel works gas producer, to those results which are usually accepted as a scientific basis of producer practice, and also to compare the data so obtained with those supplied by other steel-making firms. Particularly it is intended to show impartially, from an operator's point of view, the relative merits of the non-mechanical and mechanical types of producers as used by the firms co-operating in this investigation. Considerable test work has been carried out on one of the three producers used in conjunction with one of the 60-ton Siemens furnace units of the Park Gate Iron and Steel Company, Limited, and the data obtained have been used to form a basis for technical comparison. The producer is of an old type which has been revised from time to time, as suggested by experience, in order to adapt it to the conditions of work. It is admittedly not without faults from a scientific standpoint, yet it is used for the purpose indicated with confidence, in view of the increasingly good results which have been obtained in the furnace practice for a number of years past. The synopsis of the paper is as follows:—

(1) A consideration of the chemical and thermal balance in a producer with the same saturation temperature, but different depth of fuel bed.

(2) A consideration of the chemical and thermal results effected by varying the saturation temperature when using fuel beds of different depths.

(3) A consideration of the detailed schedules of British steel works gas producer practice along with information calculated from the data.

(4) A consideration of the arrangement of a producer plant of the non-mechanical type, and that of a plant of the mechanical type, each designed for similar capacity and conditions of service.

(5) A consideration of the comparison of capital cost, labour, and maintenance on the two plants indicated in (4), and the determination of the cost of gasification in each per 1000 tons of coal charged, under the most modern conditions.

Mr. Benjamin Talbot, in opening the discussion, said that at the works with which he was concerned, mechanical producers had been installed and had given good results, and Mr. F. W. Harbord emphasised the importance of fuel economy in producers, and expressed the hope that the time would come when it would be possible to do away with producers altogether.

Mr. W. H. Patchell referred to a non-mechanical producer of a 60-ton plant, of which he had experience. He agreed that a great deal turned on the quality of fuel available, and shared the opinion with others that with good fuel and a mechanical producer the ash content was much reduced.

Mr. Cosmo Johns, speaking from experience of both hand-worked and mechanical producers, said that the one thing that was essential as regarded efficiency was the question of the radiating hearth; that was the one feature of a gas producer which was really valuable, because it distributed the fuel in the best way, and also served to diminish the amount of channelling and discharged the ash in the proper manner.

Mr. A. H. Lymm asked that attention should be given to the real meaning of the phrase "efficiency of the gas producer." A suggestion had been put forward some time ago by the Institution of Mechanical Engineers, that a definition should be laid down by engineers generally as to what was meant by the efficiency of the gas producer, but so far as he was aware nothing had yet been done.

Mr. J. R. George referred to the relative positions of the so-called hand type of gas producer, and the gas machine in the United States. Practically no hand-type gas producers were now being installed in the United States, and there had been none installed for four or five years. The increasing cost of coal and the shortage of labour put the hand type of producer out of the running entirely. The use of producer gas plants in the United States was not increasing at a very great rate, nothing like in proportion to the increase in the output of steel, for the reason that they were using a mixture of tar and coke-oven gas very successfully in the open hearth. That gave a large amount of gas. They were also using large quantities of oil in the open hearth, and also for heating. There had been one detailed improvement; that was the development of a multiple type of blower which had a very high efficiency and was practically noiseless.

Mr. J. A. Smeeton said that the experiments which had been made were very useful in showing what could be done with ideal fuel, but, unfortunately, very few works in this country were able to work under such ideal conditions; they had to use the fuel which was placed at their disposal. If they asked any colliery works for a definite quality of coal they were told it was impossible to supply definite qualities. Some years ago he was installing a gas-producer plant, and the kind of fuel supplied was such that 70 per cent. of it would go through a one-eighth mesh; it was nothing but dust. It also contained a very high percentage of ash, as much as 40 per cent. of it came out of the ashpan. Mr. Clements paper proved that the fixed grate producer had had its day.

Dr. W. H. Hatfield said that besides Mr. Clements' great personal contribution in the paper itself, it should not be forgotten that several firms had in a broad-minded spirit placed their data before the members of the Institute. They had, indeed, taken very great pains to supply Mr. Clements with a complete set of facts. The whole of the data was most interesting. He was much amused with the suggestion that Great Britain was following in the wake of America. If United States practice was compared, for example, with that of good British practice; it would be found that the combustibles in the American gas were something like 35 per cent., and that gas producers in Great Britain were giving up to 42 per cent. There was one essential feature which must not be overlooked. In some experiments which were conducted two or three years ago, it had been possible to obtain the temperatures required right throughout the bed, and it was found that the gases on leaving the producer were at 600 deg. The maximum temperature in the producers occurred at a point 3ft. 9in. below the surface level of the coal in the producer and reached 1125 deg. Cent. Mr. Clements would agree that the 1400 deg. Cent. which he gave, and that figure of 1125 deg., pointed to a variation in producer practice in relation to the maximum temperatures attained which was worthy of further study.

Mr. Patchell said that before Mr. Clements replied to the discussion he would like to say a word arising out of what Mr. Lymm said with regard to the efforts which had been made to get the Committee together to consider producer efficiency. A joint committee was now sitting to discuss the engine codes which had been originally drawn up by the Institution of Civil Engineers. The question of gas producers formed a part of the heat engine code, and in his opinion it would be quite easy to get the committee to consider the question which Mr. Lymm had raised.

Mr. Clements, in a short reply to the points raised, said he agreed that there ought to be a definite basis for the efficiency of the gas producer. It was most inchoate at present, and there were no means of comparing the work of one machine against another. From one point of view, the efficiency of a gas producer did not vary, because if the producer were fed with a grade of gas low in calorific value, the volume would be large, and the actual amount which was represented in the gas itself, if they took into account its sensibile heat and its calorific value was practically the same throughout the whole set of conditions. They had to correlate that with the actual effect of the gas itself in the furnace. That would be the ideal way of doing it, but frankly he did not see any way of connecting the two at the present moment. Turning to the question of mechanical *versus* hand type producers, he would point out that the comparison made in the paper was based on as fair and unbiassed lines as possible. It had been suggested that he was in favour of mechanical producers. That was not the case. He was, however, always in favour of the best thing if it could be obtained. In the case of an entirely new plant, mechanical producers would doubtless be installed whatever the character and quality of the coal available. As to what type of producer one would put in, that was an entirely different matter; one always liked to get the best, of course, but the virtues which were sometimes demonstrated by those who sold the producers were not always obtained by those who had to use them. The paper was the last of a trio, the objects of which were to apply the methods of thermo-chemical analysis to three important sections of iron and steel work production, the blast-furnace, the Siemens furnace, and the gas producer respectively. The purpose underlying each had been the same, namely, heat economy. From definite evidence which he had received from Italy, France and Germany, British work had been followed with very close attention, but nowhere with the keenness which had been shown in the United States. It was difficult to estimate whether it had had any practical effect in this country, but he would like to give the actual figures of what could be done. He had taken from their Park Gate records over sixteen consecutive weeks—over three periods, the output of ingots and the coal used at the producers over those periods per ton of steel made. The first period was in 1919, before any revision at all had been made in their practice. The second period was in 1922, after the furnace had been revised as far as they could possibly go along the lines suggested to them last year; and the third period was in 1923, after the producers had been investigated and readjusted again along the lines which he had been trying to demonstrate in his last paper. The conditions of furnace charge and the method of operation remained the same over the three periods. The coal per ton of ingots was as follows:—In 1919, 5.33 cwt.; in 1922, 4.92 cwt.; and in 1923, 4.59 cwt. Those results, as stated, were over the whole output of the shop, and if they took some of the furnaces individually the results were startling. Surely he need not emphasise the significance of the total reduction in fuel of practically three-quarters of a hundredweight, which was 14 per cent. on the original figure. That had been done consistently, and the end was not yet reached because he noticed the figures for the month of March were 4.34 cwt. He was convinced that it was along lines such as those indicated that some measure at least of the future prosperity of the steel industry would lie.

Mr. J. E. Fletcher then read a paper "On Some Characteristics of Moulding Sands and their Graphical Representation."

He said that those of them who were particularly associated with the foundry trades were interested at the York meeting in hearing a paper on moulding sands by Mr. Holmes. Having done a certain amount of work in connection with moulding sands on behalf to some extent of the British Cast Iron Research Association, which was doing work in that direction, he thought that his note on moulding sands might be of service.

MOULDING SANDS.

The present paper is a description of an attempt to indicate some of the important characteristics of moulding sands by means of a simple subsidence method.

For general handiness and practicability, test tubes of 35 mm (1⅜in.) internal diameter and 230 mm. (9in.) long have been employed. The sand to be examined is slowly dried and passed through a 12-mesh sieve, fed into the test tube slowly through a funnel, and gently shaken to a level of 3in. above the bottom of the tube. Tap water, cooled to 15 deg. Cent. after boiling, is poured into the tube, covering the sand by a depth of 4in. The water and sand are then vigorously shaken by hand, a method found more effective than mechanical stirring or whirling, and yielding more regular results. After shaking, the sand is allowed to settle in the vertical tube for, say, five minutes, when the water level will be found to have subsided by a definite amount, the new level remaining constant. The volume represented by the fall in the water level is a measure of the voids between the sand, silt, and clay grains, and furnishes an index of the type and openness of the grain packing, and also approximately of the gas permeability of the sand.

The tube is next filled to the brim with water at 15 deg. Cent. and shaken as before until, by a similar indication, mixture is effected. At the moment of complete mixture of the water and sand the tube is held vertically, and the time taken for the fall of the sand grades (C.S., M.S., and F.S.), the level of which rises until the sedimentation of these grades is complete, is noted. The moment chosen for the up-ending of the tube and its contents is the time taken as the commencement of the test, and the time taken for the subsidence of the sand grades affords a measure of the mean size of the grains in these grades. With some sands it is possible to time the sedimentation of two or three distinct grain sizes in this first subsidence.

MACHINE USED FOR LINING CAST IRON PIPES WITH CONCRETE

THE STANTON IRONWORKS COMPANY, LIMITED, ENGINEERS

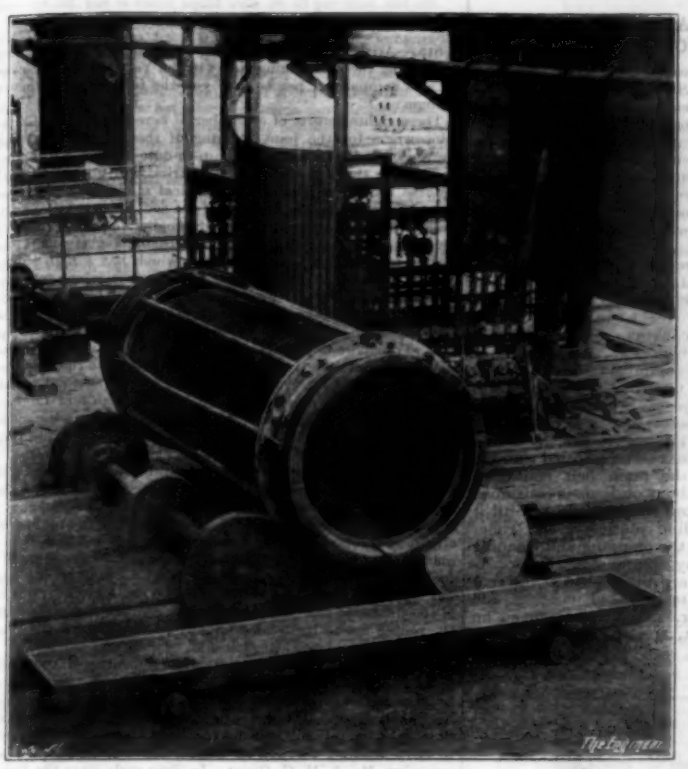


FIG. 1—THE MACHINE AT REST

FIG. 2—THE MACHINE IN OPERATION

The tube is next placed to rest in a truly vertical position and the level of the silt and clay subsidence noted every one or two minutes for one hour, and, later, every ten minutes, until a stable level has been reached. As the silt and clay subside the level of demarcation between the more or less clear water and the underlying mixture (silt + clay + water) is clearly defined.

THE SUBSIDENCE DIAGRAM.

On plotting the results on a time base a curve characteristic of the moulding sand under test is obtained. Uniform size of the sand grade grains is, of course, of primary importance, but as the gas permeability of a moulding sand is controlled by the type of grain packing, the effect of the silt grade, which so often mars the efficiency of an otherwise good sand, is well worthy of study. It is somewhat difficult to say where the silt grade ends and the clay grade begins. Such conditions militate against good gas permeability, although the sand may possess excellent bonding strength.

POROSITY AND GAS PERMEABILITY.

It has already been stated that, in the author's subsidence tests, the amount of water absorbed by the sand during the first shaking up of the dry sand and water gives a clue to the percentage of void volume. This absorption volume varies, in the sands tested, from 30 to 40 per cent. approximately. It should be noted, however, that when the coarser sand grains are settling down and the air (churned up in the shaking) is escaping, the silt and clay particles are displaced and driven upwards by air and water currents. The absorption volume indicated by the drop in the water level is therefore a measure of the voids between the sand grains washed more or less clear from the silt and clay.

Much remains to be done in the mineralogical analysis of moulding sands, and any real understanding of the bonding characteristics of a sand must be sought in the determination of the actual constitution of the silicious grain, which is the nucleus around which the bonding materials, ferric and argillaceous, are more or less statically wrapped, as suggested by Mr. H. V. Holmes in his recent paper.

The interpretation of the chemical analysis of a grade in terms of the mineral rock minerals, in their primary or altered conditions, is therefore of the utmost value. It is important to know whether the free silica in a sand grain is firmly attached to its felspathic neighbour, or whether as a slippery faced crystal it is incapable of properly bonding with the limonite or kaolinite in its immediate vicinity. In conjunction with the study of the subsidence curves it is essential, therefore, that the mineralogical constitution of each grain grade should be determined.

In the development of synthetically made or mixed moulding sands and in the scientific preparation of moulding sands it is hoped that the suggested line of study indicated in the paper will be of use to foundrymen. The author's methods are admittedly in the nature of works determinations and will undoubtedly be improved upon. They have already proved of some considerable practical value, and have been used in giving advice to a number of the members of the Cast Iron Research Association.

The morning session then concluded.

Concrete-lined Metal Pipes.

DURING the last few years the pipe manufacturing industry has been marked by rapid progressive development which has not only in some cases completely revolutionised methods of manufacture, but has given rise to entirely new types of pipes. One of the early departures from the standard cast iron pipe was the concrete pipe, which is now widely used for drainage and low-pressure work.

The present article deals with an intermediate type of pipe made by the Stanton Ironworks Company, Limited, which was suggested by, and grew out of, the Stanton-Hume process of making reinforced concrete pipes and which, for both small and large high-pressure pipes, has, we believe, an important future before it. Before dealing with its qualities and manufacture it may be of interest to refer briefly to the effect of incrustation in water pipes which the concrete-lined pipe has been designed to overcome.

INCRUSTATION IN WATER PIPES.

The question of avoiding the incrustation which takes place on the inside of a water pipe is one that has long exercised the minds of water engineers. Much has been written on the relative advantages of steel and cast iron pipes from the point of view of their ability to prolong the period which may elapse before incrustation assumes serious proportions. In actual practice it has been the general rule to lay down a pipe of larger diameter than that actually required for the full discharge of the requisite quantity of water, in order to compensate for the reduced diameter and increased resistance to flow which is directly

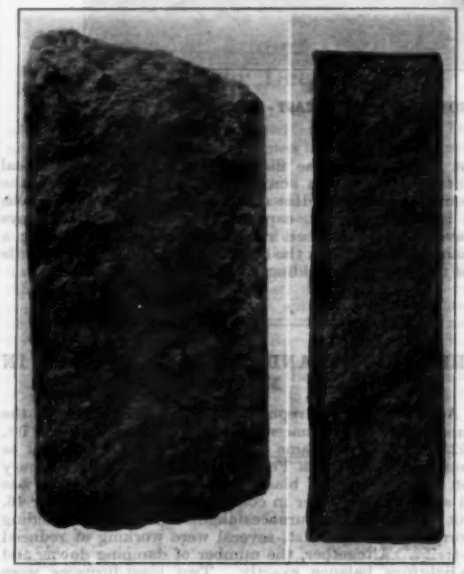


FIG. 3—HAND AND MACHINE-MADE CONCRETE LININGS

caused by incrustation. Such extra delivery allowances have been assessed by different authorities at figures varying from 35 to 55 per cent., and this factor is one that greatly increases the prime cost of the metal pipe line. In general the causes of incrustation in water may be directly traced to vegetable or organic origin, the deposits in many cases being laid down by that class of fresh-water micro-organism known by the name of iron bacteria. Experimental research has also called attention to pitting arising from local electrolytic action which may be set up by the different chemical composition of the adjoining portions of metal and scale on the interior surface of the pipe.

With the purpose of overcoming difficulties arising from these sources it has been American practice for some years past to line metal pipes with a thin coating of cement, which usually does not exceed three-eighths of an inch in thickness, applied by brush, cement gun or by hand tamping. The experience gained with such pipes, some of which have now been in continuous service over periods of eight to ten years, showed that no appreciable incrustation had taken place even with bad waters. The iron or steel pipe lined with cement was found to have the further advantage that the interior surface could be rendered perfectly smooth —making its coefficient of friction not appreciably different from that of a new cast iron pipe.

STANTON CENTRIFUGALLY CONCRETE-LINED PIPES.

The problems we have referred to were closely studied by the Stanton Company, and in the course of the experiments which were carried out the idea of the centrifugally concrete-lined metal pipe was discovered in an unexpected way.

It is well known that the company has laid down a very completely equipped plant for the manufacture of spun concrete pipes under the Hume patents. The pipes are formed in thin sheet steel moulds with a longitudinal joint, which enables the mould to be opened out and the pipe extracted after spinning and conditioning. These moulds were found to be fragile and expensive in maintenance and of little value as scrap material when no longer fit for use. The conclusion was reached that if the concrete pipes could be spun in a cast iron mould the maintenance cost would be decreased and the value of the mould itself could be realised when it was no longer fit for further service. For the purpose of testing this idea a cast iron mould, highly polished on the inside and well oiled, was made. A concrete pipe was then formed within it by spinning it on one of the machines shown in the illustrations we reproduce in Figs. 2 and 3, after which it was found that no pressure which could be applied on the end of the concrete pipe was sufficient to remove it from the mould. In other words, the concrete had taken so firm a hold on the grain of the metal that it was not possible to remove the pipe from the mould.

The result of the first experiment led to a closer investigation of the problems involved in lining metal pipes with concrete by mechanical means. In the development stage the company was fortunate in being able to make full use of the various patents relating to the work in hand, which included Israel's patent and the several patents of Hume, which cover more especially the method of driving the pipe by friction during the time the material is centrifugally deposited.

THE PROPERTIES OF SPUN CONCRETE.

Having outlined the first steps some account may now be given of the results obtained and the various application of the method. The wide difference in composition between spun concrete as made in the Stanton-Hume process and that moulded by hand in the ordinary way is clearly shown by the micro-photographs of two specimens taken from concrete pipes shown in Fig. 3. The actual operation of lining the pipes with concrete by centrifugal means is illustrated by two views taken in the main machine bay, which we reproduce in Figs. 1 and 2. This section of the works is also used for making Stanton-Hume concrete pipes, and machines are provided for spinning six or seven pipes together in the case of smaller pipes, while the larger pipes are spun singly as shown. The shop is equipped with rail tracks leading to each machine, the pipes being transported on trucks and lifted on and off the machine by a 5-ton overhead crane. The materials for making the concrete, such as the sand, cement and granite chips, are stored in bunkers adjoining the machine bay, and the preparing machinery comprises a sand washing and cleaning plant. The sand and cement are lifted by grabs from the storage bunkers into top hoppers, which automatically deliver into measuring apparatus, which in turn discharges into the mixers. The mixed concrete is delivered into troughs

alongside each machine or directly on to the hard floor.

As will be seen from the illustrations, Figs. 1 and 2, the rotary motion is imparted to the pipe by four friction wheels driven by chains and operated by a hand-controlled variable-speed motor. The speed control gear is not shown in the illustration. In the case of the larger diameter pipes, such as the 47in. pipe shown on the machine, two driving rings connected by tie rods are fitted to the pipe, which provide a means of previously adjusting the pipe so that it runs smoothly throughout the operation. These rings are also provided with a peripheral driving face which engages with the four friction wheels.

The pipe having been trued up, internal rings are placed in position in order to prevent the concrete coming out at the ends of the pipe during the spinning process. During the first spin the pipe is rotated slowly over a period of about ten minutes, during which time the sand and cement concrete is shovelled into each end of the pipe by hand. This operation is one requiring some judgment and skill, and for the largest pipes two men are required at each end of the pipe in order that the entire length of the pipe may be covered in the shortest time and an equal thickness given. Owing to the centrifugal force the cement does not fall down, but adheres to the surface of the pipe, and further consolidation is effected by passing a 3in. diameter rod with a bronze sleeve through the pipe and pressing this by hand against the revolving internal surface. After the correct thickness has been deposited the pipe is spun at a higher speed, which drives the coarser particles of the concrete towards the iron surface of the pipe and gradually expels the water and slurry from the internal surface. During the spin the water and slurry form a thin revolving film, which, as soon as the pipe is brought to rest, falls in a deluge to the bottom of the pipe. The internal end rings are then removed and the water brushed out. The concrete lining is now quite hard, and after three to four weeks in the open the pipe is ready for service. In the larger pipes the lining is about ½in. in thickness, but it may be increased up to 1in. or more if so desired.

In Fig. 4 we illustrate a series of 54in. diameter concrete-lined cast iron pipes which have been ordered for the Manchester water scheme. A pipe of much smaller diameter is also shown, and it may be noted that pipes as small as 4in. in diameter are lined. On the other hand, the largest machine is capable of dealing with pipes up to 72in. in diameter. The concrete lining is so finished at the socket end that when the joint is made the water in the pipe is only in contact with concrete and does not touch the iron in any part.

Tests which have been made on a large-diameter pipe show that the concrete lining is not affected when the pipes are cut either by the hand process or in the lathe, and that the concrete breaks with an even fracture along the line of the metal and does not split off. The pipe may also be drilled and tapped without the concrete unduly breaking away at the edges of the hole, while the operation of running and caulking the joint can be carried out without detrimental effect on the lining. The effect of exposure to the weather has been investigated by leaving a 48in. diameter pipe in the open for two years, and although subjected to effect of sun and frost no alteration has been detected either in the metal or in the concrete. A modified form of construction is represented by a series of 60in. diameter pipes which are now being made for the Birmingham Corporation. The shells of these pipes, which are manufactured by Clayton and Sons, Limited, of Leeds, are made from ¾in. steel plates bent and welded into a 5ft. diameter circle. The steel tube is so light that when the finished shell is placed on the ground it takes up a more or less oval form, being distorted in diameter by nearly ¾in. These tubes are filled with a concrete lining 1¼in. in thickness, which, when formed by spinning, is sufficiently strong to prevent all distortion and give to the pipe a perfectly round shape. This fact indicates the extent of the support which is afforded by the spun concrete lining.

The process of centrifugal lining has also been most successfully applied to the new spun cast iron pipes which are being manufactured at Stanton in sizes from 4in. up to 15in. in diameter. The spun cast iron pipe has not only the advantage that it is nearly 25 per cent. lighter than the ordinary vertical sand cast pipe, but the way in which it is made ensures a perfectly round and true pipe, avoiding the necessity of re-truing before the lining process. The new type of pipe we have described and the method of forming the concrete lining is claimed to be the cheapest and most mechanically sound which has yet been evolved, and its application certainly makes an important forward step in the art of pipe making and the development of the British pipe industry.

FIG. 4—LARGE AND SMALL DIAMETER CONCRETE-LINED CAST-IRON PIPES

FOUNDRY MATERIAL HANDLING APPLIANCES.

A new foundry for producing motor car castings for the Ferro Foundry at Cleveland, U.S.A., is an example of the application of mechanical devices to foundry work. The capacity is 1000 engine cylinders daily, these being of three types made at three separate moulding units, while a fourth unit provides for piston production. For each two units there is a sand-handling equipment. Flasks at each unit are shaken out over a floor hopper, the two hoppers being over a belt conveyor. The flasks are emptied so soon after pouring that the sand is not very dry, but about a shovelful of new sand is added for each flask. The conveyor discharges to a revolving screen mounted on live rollers, so as to eliminate a shaft, and the clean sand passing through the screen goes to another belt, the far end of which passes over a magnetic pulley and discharges to a vertical conveyor consisting of a belt with metal buckets attached. At the third floor the sand is again delivered to a conveyor, on which it is sprayed with water and then finally reaches the 80-ton storage bins. From the bin the sand passes through a chopper and then an agitator before going to conveyors, which deliver it to bins over the continuous moulding machines. For cleaning, these bins can be emptied through bottom spouts delivering to the main belt conveyor, leaving the magnetic pulley. About an hour is consumed from the time the sand is shaken from the flask until it is again shaken out. Travelling platforms and roller conveyors carry the castings to the chipping and cleaning room and thence to the railway shipping platform. As the castings move along they are taken off at different points for grinding, chipping, testing and gauging, and then put back on the conveyor. Moulds are moved on conveyors to the pouring point, and then to the shake-out point, where the flask is shaken by a mechanical vibrator. A return conveyor delivers the flask to the moulding machine. Hot metal is carried from the cupolas in ladles of 1000 lb. capacity, suspended from trolleys travelling on overhead runways, each trolley having a chain hoist by which the ladle is tilted. Air hoists handle the flasks of the moulding machines.

FRENCH IRON AND STEEL PRODUCTION IN MARCH.

According to the report of the Comité des Forges, the number of blast-furnaces alight in France on April 1st, 1923, was 77, the same figure as on March 1st, and as compared with 90 on February 1st and 116 on January 1st. The number of blast-furnaces ready to operate was 96 and of those either in construction or under repair 46. Out of the 46 blast-furnaces alight in the east—including Lorraine—on April 1st, several were working at reduced activity. Altogether, the number of damping downs and re-lightings balance exactly. Two blast-furnaces were damped down in Lorraine during March and one was able to be re-lighted in the central region and one in the south-east, so that the total of those kept damped down on account of the scarcity of coke was still 39 compared with those alight on January 1st.

The production of pig iron in March amounted to 316,146 tons, against 305,526 tons in February, an increase of 10,620 tons. The figures for the production of steel during March indicate, in comparison with February, an increase of 26,020 tons, the output having risen to 315,807 tons.

During the same month Lorraine contributed 88,652 tons of pig iron and 79,222 tons of steel, against 101,356 and 84,484 tons in February. Taking into account the shortness of the month, the average daily production was practically the same as in February. Compared with the January and December production of pig iron, the March total showed a decrease of 34.9 per cent. and 38.4 per cent. respectively. The decreases in the case of steel were 22.6 per cent. and 23.90 per cent. respectively.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

COAL MINING IN THE YANGTSE BASIN.

Sir,—Arising out of a letter published in your last issue concerning the coal-mining rights in the Yangtse Valley, owned by this company, I beg to give you the following information thereon :—

These rights consist of a number of agreements with Chinese mineowners for the joint working of their coal mines under European supervision, and with up-to-date European machinery and plant, the agreements being strictly in accord with the Chinese mining regulations. Technical mining authorities are agreed as to the potential value of the coal areas in the Yangtse Valley, and their proximity to Shanghai, &c., should prove them of great value for bunkering ocean-going steamers, &c., in lieu of importing Japanese coal, which has a high sulphur content. Several of the Yangtse Valley mines, which total over 300 in number, are at present being worked by crude native methods. Their average working costs are stated to be 2 dollars (Mex.) per ton, and local sale prices average 10 to 15 dollars per ton. Transport to Shanghai, &c., averages about 2.50 dollars, and sale prices there average 20 dollars per ton, so that there can be no doubt as to the profitable nature of the proposal. Under the joint working agreements which the Heng-Chow Company has secured, it is proposed that Chinese-European companies should be formed in accord with Chinese regulations, each with a capital sufficient to work and develop selected groups of mines by modern methods. The capital is to be found by the European side of the concern, the Chinese contributing their mines, which are to be reckoned as equal to the amount of capital provided by the European side. A minimum preliminary advance, regulated by the agreement, or by valuation, is to be made to the mineowner by the European side on account of such plant, buildings, tools, &c., as may be now on the mine, but that advance is first to be repaid to the European side out of the profits of the Chinese-European company, and thereafter the profits are to be divided equally to accord with the shareholding of 50 per cent. to each side.

Mr. T. M. Ainscough, who was commissioned by H.M. Government in 1916 to report upon mining generally in China, stated, in an excellent report, that "the success of any mining project in China depended largely upon experienced handling and Chinese co-operation," and this the Heng-Chow Company claims to have attained through its mining engineer and local representative, Mr. A. M. G. Grant. In their early days the Peking Syndicate and the Chinese Engineering and Mining Company experienced great difficulties in establishing themselves with the Chinese, but both are now flourishing concerns, with constantly increasing coal outputs. The mineowners with whom the Heng-Chow Company has arranged agreements, however, are most willing and anxious for European co-operation, realising as they do the immense advantages to be gained by employing modern machinery and methods. If the Heng-Chow Company's programme can be realised, there should be a fine opening for coalmining machinery, &c., in the Yangtse Valley, and it would largely improve the prospects of shipping, which now finds it a difficult and expensive matter to obtain good coal at Hankow, &c. It is also interesting to note that an extension of shipping is being made west of Hankow, and that trade is being opened up on the Upper Yangtse with some success, in spite of the disturbed state of the country.

For and on behalf of Heng-Chow Co., Ltd.,
Henry B. Clefford, Secretary.

London, May 10th.

DESIGN FOR EXPRESS LOCOMOTIVE.

Sir,—The design for an express locomotive, p. 429, and Messrs. Brewer's alternative suggestion, p. 507, are unaccompanied by indicator cards, which are the power measure. With three 18in. by 24in. cylinders, as suggested on page 429, the mechanical tractive effort constant is $1.5 \times d^2\, l \div D$ .80in. = 145.8, and the maximum indicated mean effective pressure with 0.65 maximum cut-off, with full steam pressure in the cylinders, at about the fourth revolution from starting the train, is 152 lb. per square inch, the indicated tractive effort being 152 × 145.8 = 22,160 lb. maximum. Without change of cut-off, the indicated mean effective pressure progressively decreases with the increasing speed. On page 507 it is questioned whether the 25 per cent. cut-off, as named on page 429, col. 2, would develop the power required for 500–600-ton trains at 60 miles per hour. Tests show that with "Pacific" boilers, four cylinders 17in. by 26in., maintain close on 60 miles per hour average, with trains of 600 tons, on nearly level line, but with a distinct fall in net altitude; the throughout average cut-off being 25 per cent.—oscillating between 15 and 40 per cent.—with full boiler pressure, the throughout average power being 1300 indicated horse-power and 920 draw-bar horse-power.

With three cylinders, 18in. by 24in., the mean effective pressure indicated at 252 revolutions per minute, or 60 miles per hour, with 25 per cent. cut-off, is generally 29 per cent. of the boiler pressure = 52 lb. mean effective pressure indicated, at 180 lb. boiler pressure. The power indicated at 60 miles per hour is therefore 1213 indicated horse-power—not "1600 indicated horse-power maintained."

At 0.4 cut-off at the same speed, the mean effective pressure indicated at full boiler admission is generally 34 per cent. of the boiler pressure—that is, nearly, 62 lb. per square inch mean effective pressure, the indicated horse-power being, therefore, 1450. The maximum power is reached at about 270–280 revolutions per minute, with 0.35 cut-off—about 1500 indicated horse-power—but not maintained continuously. At maximum points, occasionally realised when operating at 48–50 per cent. cut-off at full speed, the highest powers indicated by recent maximum efficiency American and British locomotives are 21 indicated horse-power per ton, 19.5 indicated horse-power per ton at maximum maintained power rates, while with short cut-offs of 25 per cent. for low tractive efforts, they are usually 17 and 18 indicated horse-power per ton. On these rates, the proposed engine would weigh 71–72 tons, and indicate 21 indicated horse-power per ton maximum and 20 indicated horse-power per ton continuous at 0.4 cut-off at 60 miles per hour. At 25 per cent. cut-off the power per ton is 17 indicated horse-power.

At 25 per cent. cut-off the indicated tractive effort is 52 lb. × 145.8 = 7580 lb. This cut-off of 25 per cent. is less economical than 32 per cent. cut-off, tests made with high superheat and with specially large feed heaters in operation giving an average of 19.7 lb. water per indicated horse-power-hour and 28 lb.

water per draw-bar horse-power-hour, with, as just mentioned, 1300 indicated horse-power and 920 draw-bar horse-power averages, in hauling coach loads of 600 tons at nearly 60 miles per hour on an easy profile. This water rate per horse-power-hour increases with 20 per cent. cut-off, decreases with 32 per cent. cut-off, but is about equal with 40–42 per cent. cut-off.

The alternative, as suggested on page 507, of only two live steam cylinders, 17in. by 25½in., and utilising their exhaust for power, almost equals the cylinder volumes of the P.L.M. "Pacific" compounds, which continuously maintain an average of over 2400 indicated horse-power. For limited maximum cut-offs, a more suitable cylinder dimension would, however, be 18in. by 28in., outside the frames, as adopted in 1869 on the Great Northern Railway by Patrick Stirling, and with long success, but with their exhaust steam utilised in cylinders 2.5 times larger placed between frames.

If the cut-off in working is limited to only one-third more than that for simple cylinders, that extra admission compensates, to 30 per cent., higher back pressure entailed by staged expansions, and the mean effective piston tonnage indicated is then made equal in each individual cylinder of either system, as follows:—

Proposed Design for an Express Passenger Locomotive.

Limited maximum cut-off, 0.65.

	Original.	Suggested amendment.
Boiler pressure, per sq. in.	180 lb.	180 lb.
Cylinders, to be supplied by boiler direct in each case	Three, 18″×24″	Two, 18″×28″*
Cylinders for exhaust steam	None	Two, inside frames, vol. 2.5 times larger
H.P. piston displacement per rev., cubic inches	18,200	14,224
Volume at cut-off 0.4	7,315	7,112 (cut-off 0.5)
At 252 r.p.m. = 60 m.p.h., total M.E.P. per admission	62 lb. (Card 16 N)	124 lb. (Card 15 N)
Horse-power indicated	1,450	2,200
Mech. tract. eff. constant	145.9 × 62 lb.	113.4 × 124 lb.
Indic. tract. eff.	9,040 lb.	14,060 lb.
I.H.P. per ton engine	20	28
I.H.P. per ton engine, increase	—	28 − 20 ÷ 20 = 40 per cent.

* As per drawing "No. 47," THE ENGINEER Supplement, September 29th, 1871.

Design for an Express Locomotive.

	Original.	Suggested amendment.
Total consumption per hour—		
Water, lb.	28,600	28,600
Coal, lb.	3,250	3,250
Water evaporated per lb. coal, lb.	8.8	8.8
Per I.H.P.-hour—		
Water, lb.	19.7	13.0
Coal, lb.	2.24	1.48
Coach load on lines without difference of altitude between terminals, tons	550	800
Weight of engine, tons	71	80
Weight of tender, tons	55	55
Gross tonnage, tons	676	935
Coal per 1000 ton-miles, gross, lb.	80	58
Coal per 1000 ton-miles hauled, lb.	98	68

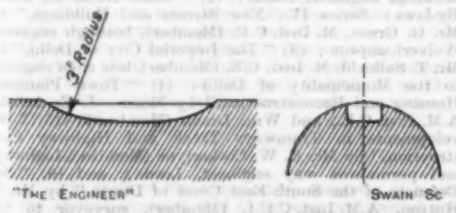
(For the higher tractive power 54 tons is employed for adhesion.)

May 14th. C. R. K.

PROPOSED STANDARD KEYS AND KEYWAYS.

SIR,—With reference to the various proposals for keys and keyway definitions submitted by the Engineering Standards Association for comment appearing in your issue of April 13th, we should like to suggest that the various keys and keyways shown be provided with a $^1/_{16}$in. radius at all four corners. We consider it of great importance to avoid sharp corners in steel shafts, especially so with regard to the ends of the keyway which are cut transversely to the shaft.

No mention is made of the "boat-shaped" keyway—see



sketch—which is very largely in use for attaching gears to tramway axles, and we think it might be advisable to include this form of keyway on the list. In this connection, we find there is a big variation in the radius of the key seats, and if a standard radius were adopted it would mean an economy in the cost of milling cutters. The size we use very largely is a 6in. cutter, and if this were standardised it would do away with the necessity for keeping different sized milling cutters in stock.

BROWN BAYLEY'S STEEL WORKS, Ltd.,
ARTHUR NORTON.

Sheffield, May 15th.

AMERICAN BOILER RATING.

SIR,—I am much obliged to your correspondent, Mr. G. A. Rossetti, for pointing out my error with regard to the American "boiler horse-power." I thought I had got the definition right, after a considerable amount of trouble, but such is not the case, and the figure of 1 American boiler horse-power should be 34½ lb. of water from and at 212 deg. Fah., as Mr. Rossetti points out.

It appears that in the United States in 1876, the Committee of Judges at the Centennial Exhibition adopted as a "horse-power" for boilers 30 lb. of water evaporated to dry steam at 70 lb. gauge pressure from feed water at 100 deg. Fah. The American Society of Mechanical Engineers' Committee on Boiler Tests of 1884 accepted this "boiler horse-power" idea, and defined it as equivalent to 34½ lb. from and at 212 deg. Fah. evaporated per hour.

The question of heating surface is mixed up with the boiler horse-power because the original American practice in boiler construction was to build boilers having 10 square feet of heating surface per boiler horse-power; that is to say, to evaporate 3.45 lb. of water from and at 212 deg. Fah. per square foot of heating surface. Thus, a boiler constructed with an evaporation of 6.90 lb. of water from and at 212 deg. Fah. per square foot heating surface would now be called "200 per cent. rating," whilst 10.35 lb. would be "300 per cent. rating."

This makes somewhat clearer the mysterious phrases in the results of American boiler tests, such as "operated at 183 per cent. rating," and it may be stated that boilers are now being constructed of 230 per cent. rating, that is, with an evaporation of 8 lb. of water from and at 212 deg. Fah. per square foot of heating surface. Why American engineers, who are supposed to be more up to date in these matters, will persist in using such a complicated, muddled and absolutely unscientific term, one is at a loss to understand, and the results obtained in the latest methods of steam generation by means of pulverised fuel firing, such as 85–88 per cent. efficiency, read strangely when mixed up with phrases thirty or forty years out of date. Surely there is only one logical and perfectly simple method of expressing the output of a boiler—the amount of water evaporated per hour in pounds from and at 212 deg. Fah., especially since boilers are not always used to provide power, and even if they were, the term "kilowatt" would be to-day a much more appropriate figure than "horse-power."

D. BROWNLIE.

London, May 14th.

NEW SUSPENSION BRIDGE OVER THE DEE

Suspension Bridge Over the River Dee.

OUR illustration represents a new suspension bridge which has recently been erected across the river Dee, near Chester. It has been designed by Mr. Charles Greenwood, Assoc. M. Inst. C.E., the city engineer and surveyor, and the various details were worked out by D. Rowell and Co., Limited, Westminster, the contractors and erectors. The main dimensions of the bridge are as follows:—Main span, 277ft. 1in.; total length, 456ft., and width 12ft. The bridge is for foot traffic only and is designed to carry a load of 1 cwt. per super foot. The main cables are four in number, of special locked coil construction, 2¾in. in diameter, with a breaking strain of not less than 350 tons per rope. The cables were made by J. and E. Wright, Limited, Birmingham. The towers are of lattice steel work and the suspender rods are 1¼in. in diameter. The anchorage on the north bank consists of a mass concrete block weighing 230 tons, and on the south bank the anchor bolts are taken into solid rock.

Prolongation of Patents.

THE proceedings in connection with the prolongation of several patents have recently been reported, and give interesting information with reference to the variation of the volume of trade in the arts in question.

The first relates to an improved pneumatic ticketing device for use with machines for balling cotton or other yarn or thread during the formation of the balls. The patent, which normally would have expired this year, has been extended for four years in consequence of the curtailment of the manufacture of the patented machine during the war. It was shown that the average manufacturing cost of the patented machines prior to the war had been £13 14s. 10d., and the average selling price £20; whereas since the war the average manufacturing cost was £50 and the average selling price £64. The number of machines sold varied from 17 in 1907 to a maximum of 32 in 1914, passing through none in the years 1916–1918, and 27 in 1920 to 19 in 1921.

The next case refers to reinforced brickwork patents, one being the well known Brown patent for bond ties for walls and the like, in which two or more strong longitudinal strands are employed to strengthen wire mesh of an ordinary pattern. Such ties may be used horizontally, vertically or zigzag for the reinforcement of walls between the courses. The second patent of this pair deals with facing bricks and blocks secured to concrete columns by bonds consisting of pieces of wire netting or hoop iron partly embedded in the concrete and projecting between the courses of facing material. Owing to the effect of hostilities upon the building trade the royalties under these patents had been considerably reduced, and the court granted an extension of 2½ years. The total royalty payments in respect of the patents varied from £17 10s. in 1907 to a maximum of over £1370 in 1912, but it appears that the lowest figure subsequently was that of £377 in 1915, and this had risen to £1304 in 1920, dropping again, however, to £575 in 1921. The case made for the applicant was that, leaving out the year 1914, which was both war and peace, the average royalties for the years 1915–1918 were £436, as against an average of £1012 for the years 1911–1913.

In the third case the shoe machinery trade comes into question, two patents being involved, one dealing with machines for levelling the soles of boots or shoes by direct pressure, and the other machines for skiving leather. It was proved that during the war the business in this machinery had been directed to the supply of manufacturers of military boots to the neglect of those for civilian use. Owing to the control and to the depletion of the stock of parts, regular manufacture could not be begun again until 1919. The figures given in court show that the number of machines sold or leased as to one patent varied from 41 in 1908 to a maximum of 61 in 1910, being reduced to 3 in 1918, but passing through 55 in 1915 and 42 in 1916, rising to 77 in 1922. As to the other patent, the figure of 131 for 1911 was reduced to 42 in 1918, and increased to 163 in 1922. On the facts before him the learned judge gave an extension of two years in each case.

Hardinge's patent relating to apparatus for crushing, dividing or disintegrating ores and other substances has been extended for the long period of 4½ years for reasons due to the war. As evidence of the state of trade in connection with crushing mills, it is interesting to note that in the years 1912 and 1913 together 35 mills were sold, the maximum being reached in 1914 with 29 mills, falling to 2 in 1917 and rising again to 26 in 1920.

Brown's ingenious patent relating to kinematograph pictures has been extended for five years. The idea underlying the invention is the embodiment in a portable form of a machine for home use, the pictures being taken by an ordinary strip film and reproduced through a microscope in a spiral series on a flat disc. The learned judge came to the conclusion that at least five years were lost owing to the war in the development of the invention.

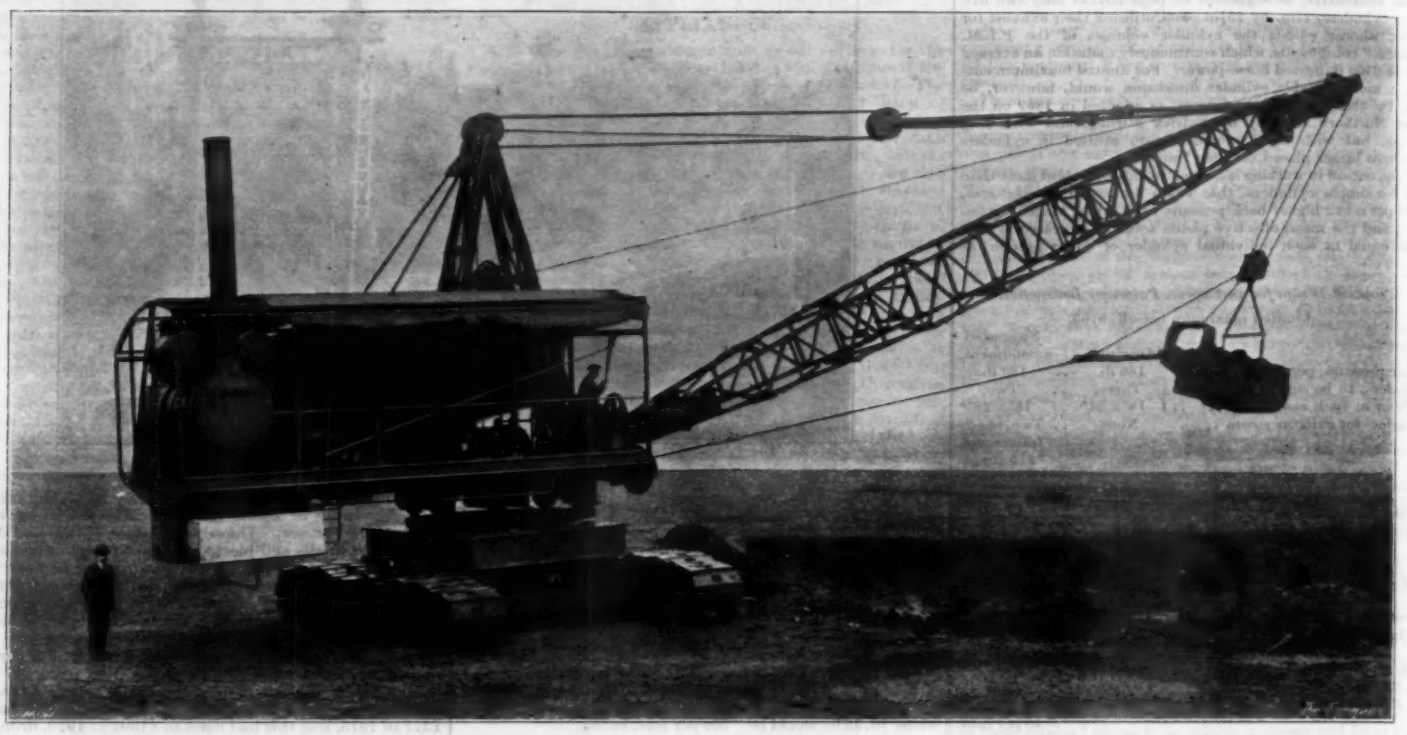
In 1906 a patent was granted to Casney and subsequently assigned to Holdsworth and Sons, Limited, relating to an invention in connection with steam generators. In this invention the internal furnace flues are made conical, the enlargement at the rear end being as great as the diameter of the boiler and the working level will allow. The increase in sectional area is roughly in the proportion of 7 to 4 and upwards, the sections being conical or cylindrical, and the flue preferably inclined. This patent has been extended for four years owing to loss resulting from hostilities. In this case it was pleaded that sales had seriously diminished owing to the coal strike and the slump in trade, but the learned judge held that these matters could not be taken into consideration, loss directly due to the war being the determining factor. That is a point that should be borne in mind in connection with engineering patents especially.

The Lebas and Garratt patent for sheet piling has also been extended, the period allowed being 2½ years. In the patented arrangement rolled metal beams of I or H-section are assembled edgeways and are locked together by rolled beams of smaller section having flanges bent over to form channels. Practically all the patented piling made and sold during the war had been constructed on account of Government contracts, the annual tonnage varying from 2166 in 1910 to 4490 in 1917, falling to 1391 in 1919 and rising again in 1921 to 2815 tons. It was pleaded that the adverse influence of the war did not cease on the termination of hostilities, but the learned judge came to the conclusion that an extension of 2½ years was as much as he should allow in this case.

WE are informed that Mr. H. N. Gresley has removed his office from Doncaster, and will in future be found at King's Cross Station, London, N. 1.

60-TON SELF-PROPELLING DRAG-LINE EXCAVATOR

RUSTON AND HORNSBY, LIMITED, LINCOLN, ENGINEERS



A Large British Drag-line Excavator.

THE drag-line excavator is a more recent introduction than the steam "navvy," and is chiefly useful for situations in which it is desirable that the machine should stand on the surface of the ground for excavating below its own level. It may be mentioned that the name "drag-line" has been adopted because the bucket is dragged in towards the machine on a flexible line or rope instead of being guided by a radial arm, as in the case of the navvy. With the latter, the digging pull is taken from the jib head, but with the drag-line the pull is obtained from the front of the revolving frame, thus relieving the jib of considerable stresses. Moreover, owing to the fact that only the weight of the bucket and contents is supported from the jib head, a much longer jib can be used than is practicable with the steam navvy.

The firm of Ruston and Hornsby, Limited, Lincoln, is making a range of these machines, varying in weight from 18 tons fitted with a ¾ cubic yard bucket upon a jib 30ft. long, up to a big machine weighing 240 tons, with a jib 120ft. long and a bucket of 8 cubic yards capacity, to run either on rails or on caterpillar tracks. The accompanying illustration and the drawing given in our Supplement represent a 60-ton machine for the Sudan, which we recently had an opportunity of inspecting in operation at the makers' testing ground. It is of the caterpillar type, and the boiler is fitted with oil fuel apparatus. The main frame of the machine, which carries the travelling gear, is built of steel sections of heavy type, securely riveted and bolted together. It runs on four chain tracks consisting of special cast steel treads running on cast steel sprockets and rollers, the whole being mounted in cast steel frames. At one end of each pair of frames provision is made for adjusting the tension on the tracks, while to allow for unevenness of the ground an equalising beam is fitted which extends across and under one end of the bottom framing, as shown in the transverse section. To this two of the caterpillar tracks are attached. The other two tracks are attached to the ends of the fixed axle at the opposite end of the frame, so that by means of a centre pivot on the equalising beam a three-point support is provided, thus ensuring that each track takes its correct proportion of the load when travelling. When the machine is in operation the equalising beam is put out of action by means of two jack screws at each end of the beam, as shown in the half-tone engraving. To ensure that the maximum area of each track is on the ground, the tracks are pivoted on the axles. Each track is independently driven by chains, and the travelling movements of the machine are controlled by driving the tracks collectively or on one side or the other by means of dog clutches. In the machine which we saw at work the total weight on the chains per square foot of area did not exceed 1 ton.

The upper or revolving frame is of heavy mild steel sections, consisting of four longitudinal members connected by means of cross girders and separators, the digging and hoisting machinery and slewing gear being mounted on the two centre members. This revolving frame is supported on four rollers each 17in. diameter, which run on a path 9ft. 6in. diameter. Steam for working the digging and hoisting and slewing engines is provided at 125 lb. pressure by a locomotive boiler 12ft. long by 3ft. 10in. diameter. The fuel tanks are mounted on each side of the boiler. In addition, a separate steam boiler is provided for operating a small turbo-electric generator, which provides current for the electric lights and "flood" lights to enable the machine to be worked during the night. The digging and hoisting engines have two horizontal cylinders 8in. bore by 10in. stroke, with cranks set at 90 deg. In addition to digging and hoisting, these engines also operate the travelling and derricking motions. The motion of the engines is transmitted to the digging drum by two sets of spur gear and a friction clutch. The pinion on the engine shaft gears with the spur wheel on the hoisting drum shaft. On the opposite end of this shaft is another pinion gearing with the digging spur wheel. The clutch is of the outside band type, the band being of spring steel and lined with Ferodo. Mild steel palms are fitted to both ends of the band, one to form the anchorage and the other for attachment of the operating gear. The power for operating this clutch is provided by means of a steam thrust cylinder on the end of the clutch shaft. A steel band brake lined with Ferodo is fitted on the digging drum, the construction being similar to that of the digging clutch. The operation is by foot pedal.

Motion from the engines is transmitted to the hoisting drum through the medium of spur gears and a friction clutch. Both the clutch and brake bands fitted to this drum and the method of operation are similar to those on the digging drum. The digging depth and radius and also the dumping or discharging radius are variable by means of a derricking jib, which can be adjusted between angles of 25 deg. and 40 deg.

The method of working the machine is as follows:—To commence with, the bucket is lowered on to the ground. The clutch or hoisting of the drag drum is then engaged, and the bucket is dragged into the excavation and towards the machine until it has become full of excavated material. The drag clutch is then released and the bucket is allowed to swing away from the machine towards the jib head radius by means of a free-lift running drum under the control of a foot brake. At the same time, to secure the necessary dumping height, the hoisting gear is also set in motion, and the bucket is lifted further out of the excavation, to a position similar to that shown in the illustration on this page.

The discharge of the bucket is quite a simple operation. When the hauling rope is kept taut, the bucket is held in position by this and the bridle rope, which passes from the drag rope round a small pulley on the pulley block to the bale of the bucket. When, however, the drag rope is released and the bucket reaches a point almost immediately under the jib head radius the bucket swings forward and downwards, and the contents of the bucket are discharged. The machine is slewed by means of a rack and pinion. The slewing engines and machinery are mounted at the front end of the revolving frame, the engines driving a vertical shaft through spur and bevel gear reduction gearing. The slewing rack and pinion have machine cut teeth. The slewing engines have two cylinders 5½in. bore and 6in. stroke, and the engines form a self-contained unit. Reversing is effected by a piston valve fixed in the same chamber as the slide valves. This reversing valve acts as a throttle valve, thus the driver has one lever only for the full control of the engine. All bearings are fitted with adjustable gun-metal steps. The derricking gear is driven from the hoisting-drum shaft, engagement being effected by means of a jaw clutch. The rope drum is driven by a machine cut worm and worm wheel. An effective screw down brake is fitted to prevent the jib running down when the jaw clutch is disengaged.

The jib is constructed of structural steel, exceptionally strong but of light design. It is built in three sections for easy shipment. The pulleys at the jib head are of cast steel, bronze bushed, and the rope grooves are machined. The length of the jib is 60ft. The fair lead consists of two horizontal sheaves mounted on a steel casting at the front of the revolving frame. Two vertical sheaves are carried in a swivelling steel casting, which is pivoted to the first casting. The construction is such that when the bucket is diverted from the direct path when being drawn in, the pulleys follow the rope and allow it to work under good conditions. The swivelling casting carrying the vertical pulleys is fitted with renewable rope guards.

The bucket is of mild steel and a lip-plate is fitted, which can be renewed should occasion arise. The trunnion brackets are of cast steel. Two holes are provided at each side of the bucket for the drag chain connections, and the "bite" of the bucket can be varied by using the upper or lower ones. The operating levers are situated at the front end of the revolving frame on the right-hand side, thus giving the driver an uninterrupted view of all operations. They are within easy reach of the driver's seat.

Two water tanks, each 440 gallons capacity, are fitted, and these can be filled while the machine is in operation by means of a water pipe which passes through the centre post. The roofing or housing is also worthy of mention. To meet conditions met with in tropical climates, the usual corrugated iron roofing is fitted together with wood on the underside with an air space of 3in. between them. At certain times of the year it is very desirable to get as much air in the machine as possible. Therefore, instead of the usual full house, waterproof side sheets are fitted and arranged so that they can be lowered down as required or rolled up and secured in position under the eaves of the roof.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.

THE fiftieth annual general meeting and Conference of the Institution of Municipal and County Engineers will be held at the Town Hall, Leeds, from Wednesday to Saturday, June 27th to 30th. The following is a list of the papers to be discussed at the Conference. They will be taken as far as possible in the order indicated, but the sequence may be varied at the discretion of the President:—(1) "Some Notes on the Leeds Sewage Disposal Works," by Mr. G. A. Hart, M. Inst. C.E., M.I. Mech. E. (Member), sewerage engineer, Leeds; (2) "Some Notes on Model By-laws: Series IV., New Streets and Buildings," by Mr. G. Green, M. Inst. C.E. (Member), borough engineer, Wolverhampton; (3) "The Imperial City of Delhi," by Mr. T. Salkield, M. Inst. C.E. (Member), late chief engineer to the Municipality of Delhi; (4) "Town Planning, Housing and Reconstruction," by Messrs. J. E. Acfield, A.M. Inst. C.E., and Wm. Dixon (Members); (5) "Developments in Tramways Track and Highway Construction," by Mr. E. W. Cockerlyne (Member), highways and permanent way engineer, Leeds; and (6) "Sea Defences of the South-East Coast of Devon," by Mr. S. Hutton, A.M. Inst. C.E.I. (Member), surveyor to the Exmouth Urban District Council. During the continuance of the meeting, visits will be paid to Templenewsam Mansion and Park and Roundhay Park; Leeds University; to the sewage works; to Leeds Fire-clay Company, Limited, Burmantofts Works; to the works of John Fowler and Co. (Leeds), Limited, Leathley-road, Hunslet, Leeds; to Thomas Green and Sons, Smithfield Ironworks, North-street, Leeds; and to Fewston, Swinsty and Lindley Wood reservoirs and the afforestation scheme of the Corporation in the Washburn Valley. Supplementary visits to the new vertical retorts at the Leeds gasworks, to the Leeds electric light station, and to the Leeds housing estates may also be arranged.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—At the annual general meeting of the Institution of Electrical Engineers, which will be held on Thursday, May 31st, at 6 p.m., at the Institution Building, Savoy-place, Victoria Embankment, W.C. 2, there will be presented to the Institution:—(*a*) An oil painting of the late Dr. Silvanus Thompson, F.R.S., presented by Mrs. Thompson; (*b*) Dr. Thompson's Library, presented by a number of members of the Institution and others; and (*c*) a bronze bust of Dr. Thompson, by Mr. Gilbert Bayes, A.R.A., presented by the Finsbury Technical College Old Students' Association.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

A Quiet Market.

THOUGH there is this week evidence of a somewhat greater readiness to purchase raw materials, the quietude of the iron and steel market in Birmingham which has been noticeable during the last week or two has not been broken to any great extent. The engineering and other orders which are being withheld on account of the high prices are not likely to be released until substantial readjustments are effected. Sellers realise that high prices are mainly responsible for the attitude which buyers have adopted, but production costs are such that they cannot see their way to grant concessions. Indeed, they are rather inclined, like sellers, to await developments, for the feeling is gaining ground, especially in steel circles, that the present lull in business is not likely to be lasting. It has been useful in correcting the effect of the inflation which prevailed earlier in the year, but now that the prospect of an easing of the political situation appears more distant than ever, it seems likely that the strength of the market will be restored. Consumers, on the other hand, are of opinion that prices will fall, and are determined not to enter into forward commitments at current prices. With opinions differing so widely, the market stupor can be readily understood.

Fuel and the Pig Iron Situation.

The pig iron position remains much as last week, prices being maintained because suppliers of fuel remain in control of the situation. Pig iron is not so eagerly sought as was recently the case, but prices are retained at about late rates. The slight instability caused by merchants unloading, who found the continental demand did not come up to their expectations, has passed. At the same time, buyers are still pressing for a revision of prices in their favour, arguing that trade development is being checked by the existing high prices. Smelters reply that they are in the hands of the coke producers, who, in spite of a declining export demand, have not modified their charges for home supplies. There is even a movement in some directions towards stiffer terms, but in view of the pressure for cheaper iron, smelters are not at all inclined to pay more for coke. Most of the furnaces are in arrear with their deliveries of foundry iron, and the coke position is such that increased production, at any rate in this area, cannot be hoped for. Forge iron has not lost further ground after the slight weakness which became manifest a fortnight ago. Northamptonshire numbers make about £4 17s. 6d., though three months' contracts are said to have been entered into in some cases at higher rates. For Derbyshire £5 and upwards is required. Pig iron demand at the moment is chiefly for foundry qualities, and there is a scarcity of Midland iron which with a little revival of trade might become acute. Northamptonshire No. 3 foundry is making £5 7s. 6d., with Derbyshire firm at £5 10s. at furnaces.

Billet Values Recover.

Billet values have recovered somewhat since last week, and it is now almost impossible to obtain material at £8 10s., which was then the quotation. It is considered that the downward run of the market was due to unloading by merchants. Steelmakers hold the opinion that the autumn will see a much stronger market. Business is this week reported at as high a figure as £9 10s., but though comparatively high figures have been paid in individual cases, business is being done at date round about £9. Continental competition in billets shows a tendency to increase. Though it is realised that it is quite possible that with the prolongation of manufacturing difficulties on the Continent competition in semi-finished material from that quarter may increase, many Midland steel masters are inclined to the opinion that the importance of this competition is being exaggerated. Nevertheless, a number of spot lots of Belgian billets is being sold in this district at prices well below those of local steel masters. The total quantity immediately available is said to be small in relation to the normal consumption. Belgian billets are quoted this week at from £8 to £8 5s. delivered Birmingham, whilst 5in. blooms are coming in at £7 17s. 6d.

Finished Steel.

In spite of the comparative slackness of buying at the present moment, and the strong continental competition, finished steel maintains a firmness which has caused some surprise. Many steel works, however, still have two months' work on hand, and consequently see no reason to make concessions. Moreover, they believe there will be a solid revival in the autumn by reason of the fact there is so much leeway to be made up that furnacemen and ironfounders are likely to be well supplied with orders. Numbers of steel works are now refusing to take forward contracts. Some mills are busy on sections, while others have little work in hand. There is a good output of light plates, but little business in heavy plates. Finished steel prices generally have undergone little change. From some of the Scottish steel works offers have been received of steel plates on the basis of £9 15s. per ton, representing a reduction of 10s. There are, however, complaints of difficulty in getting deliveries from outside the district, and works in the Midlands are still able to demand £10 5s. Structural steel values are as last week. Belgium is sending in quotations for this class of material, but they are barely competitive with those of local material. Joists and angles are quoted £8 10s. f.o.b. Antwerp for minimum quantities, representing a reduction of 5s. per ton on the quotation of a fortnight ago. This is equivalent to £10 delivered in the Black Country. In some instances, half a crown lower is quoted, but the margin is still insufficient to be attractive to Midland buyers.

Cheaper Scrap.

There has been a further fall this week of 5s. per ton in steel scrap values, bringing the price at date to £4. This further depreciation makes a total reduction of £1 per ton in a little over a month. There is a large quantity on offer, and sellers have to compete with Germany, which, owing to difficult manufacturing conditions, has now become a seller instead of a buyer of this material. German quotations are well below native prices.

Strip.

The re-rolling works in Staffordshire are very busy, and cannot undertake delivery of steel strip in a shorter period than six weeks. Prices remain firm. Amongst the busiest sections of the trade are the tube works, which are profiting by the absence of German competition in overseas markets.

Bar Iron Prices.

Keen competition from Belgium for a very small volume of business is, as I intimated last week it must do, effecting a gradual change in connection with nut and bolt bar iron. Many South Staffordshire mills would this week probably accept £11 7s. 6d. for bars suitable for the nut and bolt industry, though they still quote £11 10s. Lancashire bars are also less strong, and the £11 17s. 6d. quoted by them is no longer anything but a nominal figure. Belgian shippers have further reduced their price by 5s. per ton, and are this week quoting £8 5s. Antwerp or £9 10s. delivered Darlaston. Staffordshire makers are quite unable to compete at this price. They are paying high prices for fuel, ironworkers' wages have advanced, and taken all round production costs are such that substantial price concessions are said to be out of the question. Nut and bolt manufacturers are not at all well off for orders, and they are putting up a strong resistance to the present price level of raw material. Consequently, importations of continental material are increasing. Belgian bars are also being delivered in the district against contracts made on much lower terms towards the end of last year. Staffordshire makers who are watching with interest the activities of continental competitors, claim that the indications are that Belgium's exporting capacity is limited and that they have little to fear. Makers of marked bars are steadily employed, prices ruling unchanged at £14 10s. The demand for Crown bars is fluctuating. The general quotation for this class of material is £12 10s. Wrought iron gas tube strip continues to command from £13 5s. to £13 10s. per ton.

Galvanised Sheets.

Underselling in the galvanised sheet industry has weakened prices, and buyers find little difficulty in obtaining a rebate of anything up to 5s. per ton for good orders. The general quotation for galvanised corrugated sheets of 24 w.g. is £19 7s. 6d., though, while some mills still ask £19 10s., others are understood to be prepared to accept £19 5s. Business is fairly steady on both home and export account. Black sheets are still in good demand, and fresh orders continue to be placed for galvanised sheets.

Constructional Engineering.

Constructional engineering firms in the Midlands state that business is being well maintained, without, however, advancing on the standard of last year, as might have been anticipated from the character of orders which were placed early in the year. The demands, on the whole, are regarded as satisfactory, and certain foreign markets have been ordering fairly well, the Malay States being a notable example. Indian business is good, South Africa has improved a little, and there is more being done in New Zealand. Inquiries are stated to be exceptionally heavy, but this probably reflects the keenness of manufacturers and contractors in general in endeavouring to place orders in the most advantageous manner, and consequently sending inquiries broadcast. Prices of structural steel remain firm and high, and many undertakings continue to be held up pending reductions.

Coventry's Motor Industry.

The position in all branches of Coventry's motor engineering industry continues satisfactory. There has been tight competition in certain branches, and the increased costs of materials, like steel and tin, have had to be borne long after the season's prices had been fixed. As a result of the cut in manufacturers' prices, however, orders for light cars and motor cycles are flowing in briskly, and the makers of the larger cars are also finding business better than for a long time past. The bulk of the trade is for the home market. There is a little more movement in the export departments, but it is abundantly clear that the overseas trade has a lot of leeway to make up before anything like normal conditions are regained. Some fairly good batches of orders have, however, come to hand, emanating chiefly from New Zealand and Australia.

Railway Wagon Building.

In spite of the orders announced in this letter last week, Midland makers of railway rolling stock have still scope for more work. Orders have come in fairly well from railways abroad, and from the home electric railways, and it is fully expected that following upon the recent re-grouping of railway companies some good contracts for home railways will in the near future be issued. Carriage and wagon firms are now calling for an increased quantity of iron and steel, and their demands in the future should be even greater.

1708 Less Unemployed.

The latest unemployment returns for the Midlands area show that a further 1708 persons have in a week found employment. This, following upon the previous week's reduction of nearly 2000, would suggest that trade is moving in the right direction, and that we may reasonably hope for better things when confidence and stability have been restored to industry. In the Birmingham area the number of workless has fallen from 41,827 to 41,749; in Coventry, from 3869 to 3843; in Dudley, from 4816 to 4727; and in Leamington, from 1006 to 948.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THE dulness in the iron and metal markets here continues unabated, and there is no doubt that prices are beginning to sag under its influence. It is clear that if any sales have to be made, considerable concessions are demanded by buyers; but as there is very little business going on here, the drop in the selling prices is not particularly obvious. Makers strive to keep up a belief in the market, and as they are not in immediate need of orders they can maintain a cheerfulness which is certainly not felt by the merchants. They seem now to agree in the view held by consumers that prices have to come down, and they would no doubt be very glad to take forward orders at considerably less than the nominal prices. There is, however, very little forward buying here. Consumers are working upon old purchases and producers are relying upon old sales, and the merchant trade may be described as "left out in the cold."

Metals.

The position in the copper market is now very uncertain, and the opinion amongst experienced men differs very widely. The market was depressed up to the end of last week, and prices had lost nearly all the gain made since February. Of course, this may be a temporary movement, and it is difficult to believe that the prices can fall very much. Naturally, the expansion in production which was planned in America a few months ago did not anticipate the effects of the French occupation of industrial Germany and its disastrous results upon trade. Until industrial matters are put right there, one cannot see that the continental consumption of American copper can be restored, and in the absence of this demand, it is difficult to be cheerful about copper prices. The demand for manufactured copper and brass is kept well in check by the relatively high prices. Consumers naturally buy as little as they can do with, in the hope that sooner or later these prices will be brought into fair relation with the market quotations for copper and spelter. There does not, however, seem to be any immediate probability of this, as the margins for manufacture are now greater than ever they were. One notices that in the cotton trade the manufacturing margins are said to be one of the great hindrances to the revival of the trade; but these margins are trifling compared to those which now obtain in the manufactured metal trades, or rather in some sections of them, for in some cases they are moderate enough. There seems to be an idea about that as consumers of copper have not been buying upon any large scale for some time, it is certain that before long they must come into the market in considerable force. This may be a correct notion, but possibly not sufficient allowance is made for the fact that the consumption of copper has been proceeding only very slowly. The market confidence in tin seems to be rather less than it was when the price stood at £20 per ton more than it does now. It would be rash to attempt any forecast, but, of course, this feeling is a point on the "bear" side of the market. Continental demand is restricted, but this was to be expected until Germany can get to work again. Our own tin-plate trade is not so brisk as it was, and the American consumers are not coming forward. Lead and spelter have both been weak markets for some time, and so far one does not see any immediate probability of serious recovery. It is indeed high time that lead was cheaper.

Pig Iron.

The market here for foundry pig iron remains very quiet, and business seems almost at a standstill so far as new buying is concerned. The furnaces are well occupied, however, in the deliveries against old contracts, and sellers maintain a cheerful tone, believing, or at any rate professing to believe, that before they are in want of orders the demand will revive. There seems also to be a little less confidence now amongst the consumers in the belief that prices must fall before they need to buy again. The theory was that the export demand was at an end, and that pig iron makers must soon depend more upon the home market; but there is now talk of a revival in the export trade, and certainly the export of fuel is as brisk as ever it was, and the prices of blast-furnace coke are inclined to go up rather than to come down. The price of coke in Cleveland is what causes the makers of Cleveland No. 3 pig iron to ask 7s. 6d. per ton more than the price in Glasgow for Scotch No. 3. This is an absurd position, but apparently it cannot be put right until furnace coke in Cleveland is much cheaper. The last price heard for it was 46s.—that is, for home use—whereas in Lancashire the price of furnace coke is considered high at 32s. per ton. In Manchester sellers of No. 3 foundry pig iron are still quoting from 114s. to 115s. 6d. per ton delivered, and buyers are simply holding off the market and waiting for what they consider more reasonable prices. Probably if consumers would buy for forward delivery, say, over the next four or six months, they could get along with merchants at much less than 115s., but they are afraid to commit themselves. Scotch iron is quoted here at 130s. per ton, but there is very little business.

Steel.

There is nothing of importance in the manufactured steel market. Prices are irregular, from £10 to £10 10s. for sections and joists, £11 10s. to £11 15s. for round bars and £10 15s. to £11 for flat bars. Steel plates are uncertain, there being rumours of £10 for these, but the Midland works quote a good deal more.

Scrap.

Dealers are more pessimistic than ever with regard to scrap. Heavy wrought scrap can still be sold at 95s. to 97s. 6d. per ton, and perhaps in some cases at 100s. Steel scrap is much more difficult to sell, and it is questionable now whether 90s. can be obtained for good lots. The foundries are reported to have only a small amount of work in hand, and this is confirmed by the fact that they will not buy cast scrap even at low prices. It is possible now to buy good broken machinery scrap at 25s. per ton less than the price of common pig iron, say, at 90s. per ton delivered in Manchester. One hears even of lower prices than this.

Herbert T. Wilkinson.

Death has been very busy amongst engineers in this district during the past few weeks. The latest to be lost is Mr. Herbert T. Wilkinson, M. Inst. E.E., who was apparently in the best of health and spirits when he left England recently on a business trip to India. Mr. Wilkinson was managing director of the Wardle Engineering Company, the works of which are at Old Trafford, but he had for some time spent much of his time in London, residing at Richmond. He took a very prominent part in the formation of the Engineers' Club, Manchester, and for some time acted as honorary secretary, a position which he filled with conspicuous success. Latterly, he was a member of the Committee, and there are few persons who have contributed more to the success of this the first engineers' club in the country. Mr. Wilkinson's death occurred at sea, while he was on his return trip from India. He was a man with a charming personality and a host of friends.

The Rating of Machinery.

It is sincerely to be hoped that the fate of the Rating of Machinery Bill, which passed its second reading in the House of Commons last week with an overwhelming majority, will be a more happy one than many of its predecessors. The Federation of Master Cotton Spinners' Associations is giving unqualified support to the new measure and emphasises the necessity for uniformity of treatment. With regard to the class of machinery which rests by its own weight upon the floors of the mills, there is a great diversity in regard to the rating in different districts. In some cases it is rated at the full value; in others, at only part of its value; and in others again, it is not rated at all. For instance, a cotton mill in the Manchester area was assessed in 1914 at £1350, and with rates at 7s. 9d. in the pound, had to pay £523 per annum; at the present time, with a 13s. rate, the amount payable is £1535. A second mill, in the Wigan Union, where the rate has gone up from 9s. 2d. in the pound in 1914 to 17s. in 1922–1923, the amount payment has been increased more than 300 per cent. A third typical case, a mill at Leigh paid £1700 in rates, or 8s. 6d. in the pound in 1914 on £4000, and has now to pay 14s. 4d. in the pound on £6200, making the demand £4444, or an increase of 121 per cent. Further extraordinary increases of a similar description could be quoted. The Federation seems to have made out a very strong case against high rating in general, but a stronger one still against the disparities such as those mentioned above.

British Textile Machinery for China.

The scheme for the Textile Technical School at Shanghai is now interesting the whole of Lancashire, and is coming before both the cotton trade and the Chambers of Commerce, which are generally sympathetic. In a discussion on the supplying of textile machinery to China, at a meeting of the Oldham Chamber of Commerce, Mr. G. H. Whittaker asked for some information with regard to the importation of machinery into China. Councillor Greenwood pointed out, in reply, that the matter had been brought before the Lancashire Members of Parliament by Colonel Dobson a week or two ago. The whole matter was then explained by Colonel Dobson, and as a few minutes before the Lancashire Members had received a deputation from the cotton trade, some of the Members thought it would be better if the representatives of the machinery makers got into touch with the Cotton Spinners' Federation and asked for its views on the matter. He (Councillor Greenwood) believed cotton spinners would take the long view that so long as the people had to have machinery, it would be best to encourage the export of machinery from this country. The President of the Chamber, Mr. H. Lawton, pointed out that the spindles in China were a mere flea-bite, they being equal to not more than two or three Oldham mills for a population of 400,000,000. We should not, he urged, stop cotton spinning in China. Prior to the war the whole of the machinery was English, and the same applied to Japan. It was only during the war and since, when we had not been able to send out machinery as quickly as they wanted it, that these countries had begun to take American machinery. They preferred English to American machinery, but the Americans were making desperate efforts to get in, contending that while there were not more than two or three Chinese students in England, there were hundreds in America studying cotton spinning.

BARROW-IN-FURNESS, Thursday.

Hematite.

There is not a great amount of business being done at the present time in hematite pig iron. This is due to the fact that customers are supplied or are sufficiently booked for their requirements. Makers are holding plenty of orders to keep the present number of furnaces in blast, and there is at the present no cause to anticipate a falling off in smelting. There is a tendency for prices to come down in consequence of the quieter market, and this will tempt a few to place further orders for forward delivery. Makers of iron are fairly well booked forward, some being fixed for a number of months. The coke supply is satisfactory now, and there is no reason to expect a recurrence of shortage in the future. The shipment of pig iron from Barrow last week showed an improvement on the previous week. Cargoes left for Antwerp, Boston, U.S.A., &c. The trade with America is not as great as it was, but it will continue, as there is a demand over there for West Coast qualities. Special qualities of iron are in regular demand, but are well booked forward.

Iron Ore.

The iron ore trade continues to be fairly good. Not a great deal is going out of the district, but there was a part cargo for Antwerp last week. In Cumberland there is more being raised than in North Lancashire, but in the latter one or two mines are raising a fair quantity. There is not a large quantity of foreign arriving at present. There was no Spanish last week, but a cargo of manganese ore arrived at Barrow from Poti *viâ* Constantinople and Messina.

Steel.

The steel trade is only moderate, speaking of the whole of the district. The works at Barrow are the busiest, the rail, hoop and small bar mills being engaged. Foundries are moderately employed, with a better prospect.

Shipbuilding and Engineering.

The London, Midland and Scottish Railway combination now being the owner of the Barrow docks, which before the amalgamation were owned by the Furness Railway, there is every likelihood of its making use of the floating and dry docks at Barrow. Already there is evidence of this, for one of the lately Midland-owned passenger vessels Londonderry is undergoing repairs and overhaul there. The London, Midland and Scottish is the owner of a numerous fleet, and it may mean that Barrow will benefit from the amalgamation. Much of the work will be done by the company itself, but more important jobs will probably be placed with the local shipyard and engineering works. There are no new shipbuilding orders to report, but the prospect is brighter, and there may be more good news to communicate in a short time.

SHEFFIELD.

(From our own Correspondent.)

A Less Cheerful Tone.

THE general condition of Sheffield trade, so far from improving, shows a tendency to decline. While the heavy branches continue busy, they are hardly as busy as they have been, and the others make no progress at all. The state of things is such that a good deal of misgiving is now succeeding the high hopes of an all-round revival which had been held for some time. A very striking fact in this connection is that the Master Cutler, Mr. R. W. Matthews, has been expressing dissatisfaction with the position. As I have remarked before, the Master Cutler has hitherto been one of the most confirmed optimists in the city. His speech on accepting office was of a very hopeful character, and he has followed it with a series of others, all pitched in the same key. His latest statement, therefore, is all the more significant. We had started the year in an admirable way, he said, and everybody was full of confidence and hope that better times were ahead. Within the last few weeks, however, there had been a very decided reaction from the position as it was at the beginning of the year.

Export Trade Declining.

This, he went on, was attributable to the conditions on the Continent at the present time. This country had been content to sit and look on more or less dispassionately, wrapped in a mantle of tranquillity. He could not help thinking that if we were to maintain the recovery in our trade, it was time this country took a more definite line than it had done in the past. It was not for him to say in what direction this country should throw its weight, as his office was a non-political one; but we could not afford to stand by and see our export trade, on which we depended for our national existence, sink back into the deplorable slough from which we had so hardly rescued it.

The Demand for Crude Steel.

The steel furnaces are still very busy, and those which produce the basic variety are practically working full time. The production of acid steel, however, although still maintained on a large scale, has lately shown a falling off. In both departments, there is still very little new buying, and the majority of the orders now being executed were placed when prices were considerably lower than those ruling at present. In spite of the holding-off policy adopted by consumers, however, prices of steel are strongly maintained, although pig iron and coke are cheaper, and the position of scrap is not quite as strong as it was a month ago. Activity similar to that enjoyed by open-hearth steel prevails in the railway steel departments. These continue to book very useful orders for axles, tires and springs, and the prospects of work for the larger portion of the plants, if not for the whole of them, are good. The boom in the coal trade produced a large demand for colliery requisites, and firms supplying these are still as busy as ever.

Manufactured Steel.

When we have named these branches, we have about exhausted the list of good ones. The heavy steel foundries and forges are in a very unsatisfactory state, owing to the small requirements of the marine and general engineering trades. A good many local firms which supply Lancashire with steel materials and tools, are feeling the effects of the decline in the textile industry. In crucible steel, the long-deferred improvement is still wanting. While the slackness is not so acute as it was a year ago, there is no regular flow of orders, and such as do come in are on the small side. There is not enough trade to ensure continuous working, and much plant is idle. A rather better demand is reported for certain classes of tools, including pliers and nippers, stocks and dies, and twist drills. The improvement may be attributed to the reduction of imports from Germany, but the trades are still quiet, and are handicapped by the continued existence of surplus war stores.

The Old Staple Trades.

There is no improvement in the cutlery trade; in fact, reports are uniformly bad, and things get worse instead of better. So far as the best-known old firms are concerned, business is in a condition of slump. There are large orders for cheap goods going about, but these are principally picked up by small people who have little or nothing to face in the way of overhead charges. The best department on the cutlery side is still that of stainless knives; but the demand for this class of goods, which has been on an enormous scale for several years, is now shrinking noticeably. There is a better outlook in the scissors branch, which is enjoying an improved demand, and appears to be regaining some of its lost ground. Great slackness prevails in the razor, pen and pocket knife sections. In various parts of the world there is a demand for the cheap solid steel table knives and forks which have in the past been largely made by Germany. Inquiries for considerable quantities are now being received in Sheffield, where a few firms are able to deal with them. The trade is not a very attractive one to the ordinary manufacturer. The prices quoted for the articles named are as low as about 3s. per dozen. In electro-plate, the amount of trade being done through ordinary shop-keeping channels is very restricted, but there is a fairly good demand for hotel and café supplies.

New Light Railway.

A formal start has now been made with the construction of the Dearne District Light Railway, an important municipal undertaking promoted by the Wombwell, Wath, Bolton and Thurnscoe Urban Councils, for the linking up of all the towns and villages in the Dearne Valley with the important South Yorkshire centres. The northern terminus of the railway is in Chapel-street, Thurnscoe, and there the ground has been ceremoniously broken by Mr. Mark Nokes, Chairman of the Railway Committee. My letters during February gave considerable details of the scheme, the construction of which will involve an outlay of upwards of £200,000.

Sheffield Enterprises.

Moorwoods, Limited, of Sheffield, who are the sole licensees for cooking apparatus on the Kermode patent oil-burning system, have just supplied the saloon galley and native crew galley of the twin-screw motor-ship Ediba with a complete cooking installation. The vessel was built by Harland and Wolff for the Elder Dempster Line. It has just started its maiden trip on the West African Benin service, and is the first motor-driven ship sailing without an ounce of coal on board. T. W. Ward, Limited, of Sheffield, have just restarted their nodulising works at Barrow, for dealing with fines ores and rendering them suitable for blast-furnaces. The works were originally opened in 1920, but were closed down after three months owing to high cost of material and labour, excessive railway rates and the general decline of trade.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE Cleveland pig iron trades presents few new features of moment. Lethargic conditions continue to prevail, but there is a quietly confident undertone and renewed activity is looked for after the holidays. The disturbed political situation in Germany is undoubtedly gravely restricting the continental market for Cleveland iron, for European consumption has undergone a marked contraction in recent weeks, and the plight of the mark has rendered business with Germany almost impossible. There is still, moreover, a disposition amongst home consumers to hold off the market in the hope of lower prices, and it is understood that a fair volume of business will be placed as soon as consumers are convinced that stabilisation of prices has been reached. Having regard to the current high costs of production, further price cuts certainly seem to be improbable. Indeed, the view is expressed that a relatively small volume of business would tend to stiffen the price, as there is so little iron to dispose of. The output of pig iron is just equal to current requirements, and there are no stocks worth mentioning, and any movement towards improvement in demand would quickly create acute shortage once more. Still, it cannot be denied that makers would gladly fix up new forward contracts to replace those which will shortly expire, and they are looking for better business after the holidays. There is a report this week of a transaction in No. 3 Cleveland pig iron at 124s. per ton, which represents a reduction of a shilling, but the majority of the makers are still holding out for 125s., and 132s. 6d. is said to have been paid for No. 1. Makers are also asking up to 122s. 6d. per ton for No. 4 foundry, but probably business could be done at 120s., and at 117s. 6d. for No. 4 forge.

Hemstite Pig Iron.

A steady tone characterises the East Coast hematite pig iron trade. Mixed numbers are still being sold at 122s. 6d. per ton, and No. 1 quality at 123s. 6d., and whilst only small parcels are changing hands, the relatively lower price of this class of iron is attracting a fair amount of business. Traders generally take an optimistic view of the outlook in the hematite trade, the opinion being that there will be a marked expansion in business in the near future.

Iron-making Materials.

Imports of foreign ore continue on a heavy scale

but new business is still very quiet, and 24s. 6d. per ton is purely a nominal sellers' price for best Rubio ore c.i.f. Tees. Coke prices are steady. Good Durham furnace qualities range from 44s. per ton delivered at the works, but the scarcity is still so pronounced that it is impossible to contemplate the starting of more furnaces.

Manufactured Iron and Steel.

The steel works in this district are closing down only two days next week for the Whitsun holidays. This is an indication that, in spite of the boilermakers' dispute, the mills have plenty of work on hand to carry on, and, in fact, there is still a steady, if slightly diminished, flow of orders for manufactured iron and steel. Continental competition has not assumed serious proportions, and recent price levels are firmly maintained.

The Coal Trade.

The northern coal trade position remains for the most part quite unaltered. Everything is as firm as could well be. Apart from a few second-hand people with odd parcels of steams and occasional lots of Durham gas coals for disposal, which can occasionally be discounted, there is not much coal of any kind available. All the collieries maintain a firm front, and will not listen to anything below the top quotations this side of July. Then for the third and fourth quarters of the year a good proportion of the output has been already bespoken. Fitters are now inclined to hold back, despite the fact that numerous inquiries, both on merchants' account and abroad, are in circulation. In the export trade there are signs of awakening interest, and preliminary negotiations on the part of French, German and Scandinavian buyers are in progress. One inquiry in the market is for 100,000 tons or more of best Northumberland steams for a large German industrial firm, with delivery monthly from August to December next. The French railways also are inquiring for 15,000 to 20,000 tons of prime Durham coking coals for shipment to France during June. The coke market remains exceptionally steady for every make of either foundry or furnace coke, and is a trifle firmer for gas coke.

SCOTLAND.

(From our own Correspondent.)

Falling Off in Trade.

TRADE is pursuing a very disappointing course at present Activities on the various markets are very restricted, and there seems little hope of an early development. Home consumers can barely afford to purchase at present prices, and their operations must perforce be limited. In the export departments, high prices are not the only deterrent. Continental producers are now offering more material and better deliveries at prices which compare favourably with local quotations. In the export trade therefore it seems inevitable that prices of home productions must be brought into line. As matters are at present, the trade outlook is far from bright.

Colville Park—Welfare Centre.

One of the latest developments in industrial welfare work will be formally initiated to-morrow, Saturday, when Colville Park, formerly Jerviston estate, near Motherwell, will be opened. This new scheme is for the benefit of the employees of David Colville and Sons, Limited, Dalzell Steel and Ironworks, Motherwell, and branches, and has been bought and presented by Messrs. David, Norman and John Colville, directors of the company, and grandsons of the founder, in memory of their fathers, Messrs. John, Archibald and David Colville. The estate and mansion house are conveyed to the Dalzell workers by trust deed, and the trustees are representative of the company and employees. The mansion house will be a well-equipped club and social centre. Within the grounds there have been laid out a nine-hole golf course, two eighteen-hole putting greens, six tennis courts and a bowling green.

Pig Iron.

Pig iron producers have fair bookings to work off, but fresh business is very slow to materialise. Local consumers are pretty well covered for a week or two, and are not disposed to increase their holdings at present prices or even at the slightly easier quotations which may be negotiated at present. Export inquiries continue to come forward, but these are not bearing much fruit nowadays.

Finished Steel and Iron.

There has been a gradual decrease in business in steel and iron for some weeks past, and the situation has not been improved by the boilermakers' strike. Therefore, though in many cases makers have sufficient tonnage booked to maintain activities for a month or two, the future is anything but free from anxiety. At the present rate of buying, orders will be very scarce within a month or two, unless a rapid decline in prices takes place. Makers were hopeful of cheaper railway rates as a help towards cheaper raw materials, and are greatly disappointed at their lack of success in that respect. In the meantime, home prices are unchanged, and only in export is there any tendency to drop a little. Steel plates have been poorly bought for some time, and now sectional material and sheets are much quieter. In bar iron, too, buying on home account has practically ceased, and export inquiries are dwindling away. The same remarks apply to re-rolled steel bars. Reduced prices of scrap material are looked for almost immediately. Supplies are increasing, and are likely to be augmented by foreign arrivals.

Coal.

So far as new business is concerned, the Scotch coal market is dull. The collieries are almost all booked a few weeks ahead yet, and are doing their utmost to maintain prices at recent levels. There is, nevertheless, a weaker tendency in round coal for export, and only in washed nuts, &c., is the standard upheld. Buyers are not inquiring for much in the way of forward deliveries at present, and the day-to-day orders are of small tonnage. Export shipments are not prominent, and the coastwise traffic accounts for a good proportion of the total for the week of 352,372 tons, against 364,390 tons in the preceding week and 270,295 tons in the same week last year. Shipping facilities are now much improved at the Forth and Fifeshire ports, the turn being regular. Steamers are plentiful and freights are easier. The home market is dull and uninteresting, the only sign of strength being the steady demand for best qualities of household coal.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE conditions prevailing in the steam coal trade are typical of those usually in evidence immediately before a holiday. The docks are full of tonnage, and great pressure is being exercised in order to get steamers loaded and away before Saturday, because failure to do so means that tonnage will be held up until the middle of next week at the least, and possibly later, and this, of course, entails cost to owners. The collieries cannot meet the demand for prompt coals to load the steamers to hand, and there are a number of boats which have been ready for a week which are not likely to make a start, even this side of the vacation, so that their prospects of getting their cargoes next week are very remote, as no doubt there will be the usual scarcity of coals following a three days' stoppage of work in the coalfield. So far as the docks in this district are concerned, there will be no work on the loading of steamers on Monday and Tuesday next, and probably very little work on the Wednesday, as it is quite conceivable that coals will not be in readiness. The conditions prevailing on the market are very firm, as there is a demand for small parcels to complete cargoes, and good prices have been paid for quite inferior qualities so long as supplies were available and they could be shipped, thus obviating the holding up of steamers over the holidays. Collieries are very full up for this month, and the early part of next, and prices on the whole are stronger; but whether they are likely to be maintained very far into June is a moot point. The buying of coals has been confined to prompt lots by exporters to enable them to execute their obligations to buyers abroad, but foreign consumers are not operating for next month to any appreciable extent, as they still hold the view that current prices are likely to fall. They prefer to wait unless they can obtain their requirements at considerably less than the prices currently quoted, which means that only exporters who hold low-priced contracts can look at business on this basis, and may feel disposed to sell rather than run the risk of not lifting the coals due to them, and thereby forfeiting a moderate profit. At the same time, there are a few interesting inquiries on the market for supplies of steam coals for delivery over the latter part of the year, and these include one or two of the South American railways, while the Egyptian State Railways are open for tenders for 120,000 to 160,000 tons of steam qualities for delivery commencing in July next.

Third Shift Settlement.

It is satisfactory to announce that at last a settlement has been reached regarding the question of a third shift at South Wales ports. Negotiations were continued in London during the latter part of last week, and the outcome was that on Saturday the representatives of the coal trimmers and tippers and the employers, under the chairmanship of Mr. John Compston, the chairman of the Court of Inquiry set up by the Ministry of Labour, agreed that a partial third shift should be for an experimental period of six months, and if, consequent upon this experimental period, the third shift be discontinued prior to June 30th, 1924, the stabilisation period as affecting tariffs is to be limited to the period during which the third shift is in operation. It was considered that during the experimental period, it would not be necessary to work in the third shift more than one-third of the tips, but if at any time during the six months, in the employers' opinion, the trade warrants the working of a larger number, a meeting of the Consultative Committee which is to be set up at each port is to be called to consider whether any and what extra numbers are to be worked. The hours of the three shifts to be worked are to be as follows:—6 a.m. to 2 p.m., 2 p.m. to 10 p.m., 10 p.m. to 6 a.m., with a definitely appointed interval of half an hour in each shift for a meal time. On Saturday the hours are to be 6 a.m. to 12 noon, with half an hour's interval for meals. It is understood that the partial third shift is to come into operation immediately after the Whitsuntide holidays, and arrangements to this end are now being made. Exactly how matters will work out and its effect upon expediting the loading of tonnage it is difficult to say. Steamers should, of course, get a quicker turn, provided that the coals are forthcoming, and there is the foreign demand. At the same time, it cannot be denied that the partial third shift is coming into operation at a time when there is reason to look forward to a diminution of activity, viz., the summer months, which are the quietest period in the year. The extra facilities should have been available six months ago. It is quite possible that before the experimental period expires the men will be able to turn round and claim that there was no need for any extra working.

Steel and Tin-plates.

The Stabilising Committee met at Swansea on Saturday last, when the steel makers decided to reduce the price of steel bars from £10 to £9 2s. 6d. per ton, less 7s. 6d. for consumption at local works. Following this reduction, Welsh tin-plate makers reduced tin-plates to 23s. 1½d. per standard box. Recently the conditions in both trades have altered, the demand for both steel and tin-plates having fallen off. By reducing prices, makers hope to stimulate the inquiry.

Non-unionism.

Notices to cease work in a fortnight's time were handed in by the miners in the Merthyr and Dowlais area on Saturday last. The membership of the Miners' Federation in this district is slightly over 90 per cent., but the leaders are out to secure the full 100 per cent., and they hope that before the expiration of the notices they will achieve their object.

Dock and Railway Improvements.

The announcement of the Great Western Railway Company of projected works in this district has caused satisfaction. The directors have lost no time in considering ways and means of facilitating coal shipments from the various ports under their control. The company have authorised £500,000 on account of additional sidings on the Newport dock lines, enlargement of Rogerstone yard, additional sidings at Cardiff docks, connection between the Rhymney and Taff lines at Heath, and additional sidings at Cadoxton and at Llantrisant, while many smaller works to facilitate the movement of traffic have also been authorised, and further proposals to assist expeditious working at the docks are under consideration.

Electrical Power.

Some time ago the Cardiff Corporation reached an agreement to supply electrical energy to the Great Western Railway Company for working the new hydraulic plant at the Cardiff docks, and at the same time the Corporation took steps to order new equipment to give considerably greater power in anticipation of most of the works round the docks becoming users of Corporation current. The Cardiff Channel Dry Docks and Pontoon Company, Limited, and its subsidiary undertakings, which have had their own plant for providing electrical light, have now decided to take power from the Corporation, and it is likely that other concerns will follow their example before very long, owing to the fact that it will be more economical.

Current Business.

The tone of the steam coal market is very firm for supplies for prompt shipment, but few, if any, collieries have any coal to spare, owing to their own heavy commitments and the pressure of tonnage in dock. There is not much fresh business passing, and operations are for the most part restricted to small parcels, which exporters require to complete cargoes which they are anxious to get away before the holidays. Superior Admiralty large has firmed up to 40s. to 42s. 6d., and second qualities are scarce at 37s. 6d. to 40s. The better descriptions of Monmouthshire large also range from 37s. 6d. to 40s., while small coals are more difficult to obtain and the best grades are firm at from 30s. to 32s. 6d. Patent fuel is not quite so active in demand, while in the case of anthracite coals, the inquiry for prompt loading has rather fallen off, except for some of the sized coals and for rubbly culm and duff.

LAUNCHES AND TRIAL TRIPS.

MELPOMENE, steamer; built by the Chantiers and Ateliers de la Gironde, to the order of the Compagnie Auxiliaire de Navigation; dimensions, 425ft. by 57ft. by 33ft. Engines, 28in., 46in., and 76in. by 52in. stroke, pressure 180 lb.; constructed by Société Grovencale de Constructions Navales; launch, April 19th.

HOPPER No. 30; built by Cammell Laird and Co., Limited, to the order of the Mersey Docks and Harbour Board; dimensions, 205ft. by 35ft. 6in. by 16ft. 3in.; to carry 1000 tons. Engine, single triple-expansion, 18½in., 29½in., 40in. by 30in. stroke, pressure 180 lb.; constructed by the builders; trial trip, April 24th.

HOPPER BARGE; built by Cammell Laird and Co., Limited, to the order of the Mersey Dock and Harbour Board; dimensions, 207ft. by 35ft. 6in. by 16ft. 3in. Engines, triple-expansion; constructed by the builders; launch, April 26th.

GLENGELDIE, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Canadian Great Lakes and Canals; dimensions, 252ft. by 42ft. 6in. by 20ft. 6in. Engines, single-screw triple-expansion; constructed by the builders; trial trip, April 27th.

T.I.C. No. 20, steel screw hopper barge; built by Palmer's Shipbuilding and Iron Company, to the order of the Tyne Improvement Commission; dimensions, 175ft. by 32ft. 2in. by 14ft. 6in.; to carry 800 tons. Engines, direct-acting surface condensing triple-expansion, pressure 160 lb.; constructed by the builders; launch, April 30th.

OILFIELD, tank steamer; built by the Tyne Iron Shipbuilding Company, Limited, to the order of the Northern Petroleum Tank Steamship Company, Limited; dimensions, 365ft. by 51ft. by 30ft. 9in.; 7500 tons deadweight. Engines, double-reduction mechanical geared turbines with condensing plant; constructed by the Wallsend Slipway and Engineering Company; launch, May 1st.

RAILWAY ELECTRIFICATION.—The Westinghouse Electric International Company asks us to state that the weights of the trains on the Virginia railway, referred to in our leading article on Railway Electrification appearing in our last issue, should have been given as 6000 and 9000 tons and not 600 and 900 tons as specified.

THE JUNIOR INSTITUTION OF ENGINEERS.—A dinner to celebrate the thirty-ninth anniversary of the foundation of the Junior Institution of Engineers was held on Thursday evening of last week at the Monico Restaurant, London. It was attended by about ninety members and guests, with Captain H. R. Sankey, the president of the Institution, in the chair. The toast of "The Institution" was proposed by Mr. J. F. Etchells, president of the Institution of Structural Engineers, and was responded to by Mr. H. V. Pointon. Sir J. E. Thornycroft proposed "Modern Practice in Heat Engines," coupled with the name of Captain Sankey, to which the president replied. Mr. W. J. Tennant, vice-president, gave the toast of "Our Guests," which was acknowledged by Sir J. F. Flannery, president-designate.

Current Prices for Metals and Fuels.

IRON ORE.

N.W COAST—	
Native	26/-
(1) Spanish	24/-
(1) N. African	24/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	6 7 6	—
No. 1 Foundry	6 2 6	—
No. 3 Foundry	5 17 6	—
N.E. COAST—		
Hematite Mixed Nos.	6 2 6	6 2 6
No. 1	6 3 6	6 3 6
Cleveland—		
No. 1	6 10 0	6 10 0
Silicious Iron	6 10 0	6 10 0
No. 3 G.M.B.	6 5 0	6 5 0
No. 4 Foundry	6 2 6	6 2 6
No. 4 Forge	5 17 6	5 17 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge *	—	—
,, ,, Foundry	5 12 6 to 5 15 0	
(3) Northampton—		
Foundry No. 3	5 7 6	—
,, Forge	4 16 0	—
(3) Derbyshire—		
No. 3 Foundry	5 10 0	—
Forge	5 0 0	—
(3) Lincolnshire—		
Basic	6 0 0 to 6 10 0	
Foundry	5 10 0	—
Forge	5 5 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	6 15 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best ,,	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 15 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	15 10 0	—
MIDLANDS—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 7 6 to 11 10 0	
Gas Tube Strip	13 5 0 to 13 10 0	

STEEL.

	(6) Home £ s. d	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates ¾in. and up	10 5	-
Sections	10 0 0	—
Steel Sheets ⅛in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	20 0 0

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 0 0	—
Joists	10 0	—
Heavy Rails	10 10 0	—
Fish-plates	14 10 0	—
Channels	9 5 0	—
Hard Billets	10 15 0	—
Soft Billets	10 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	10 0 0	—
Light ,,	12 10 0	—
Billets	11 0 0	—
MANCHESTER—		
Bars (Round)	11 15 0	—
,, (others)	10 15 0 to 11 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	10 10 0 to 10 15 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	13 0 0	—
Bessemer Billets	13 10 0	—
Hard Basic	10 15 0	—
Intermediate Basic	10 10 0	—
Soft Basic	9 10 0 to 10 0 0	
Hoops	12 15 0 to 13 5 0	
Soft Wire Rods	13 0 0 to 13 10 0	
MIDLANDS—		
Small Rolled Bars	11 5 0 to 11 10 0	
Billets and Sheet-bars	9 0 0 to 9 10 0	
Gas Tube Strip	12 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	19 2 6	—
Angles	10 10 0	—
Joists	10 10 0	—
Tees	11 10 0	—
Bridge and Tank Plates	10 15 0 to 11 0 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/9 to 24/-
Block Tin (cash)	197 5 0
,, (three months)	195 10 0
Copper (cash)	65 7 6
,, (three months)	66 5 0
Spanish Lead (cash)	25 2 6
,, (three months)	24 12 6
Spelter (cash)	29 5 0
,, (three months)	29 5 0
MANCHESTER—	
Copper, Best Selected Ingots	70 0 0
,, Electrolytic	76 0 0
,, Strong Sheets	104 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 0½
,, Condenser	0 1 2½
Lead, English	26 0 0
,, Foreign	24 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£50 0 0	18/-
,, ,, 1 p.c. ,,	£60 0 0	21/-
,, ,, 0·75 p.c. carbon	£70 0 0	22/6
,, carbon free	1/6 per lb.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£16 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£21 0 0 scale 6/- per unit	
,, Vanadium	16/9 per lb.	
,, Molybdenum	9/6 per lb.	
,, Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	12/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	26/-
,, ,, Ell	28/-
,, ,, Splint	29/- to 31/6
,, ,, Trebles	29/3
,, ,, Doubles	28/-
,, ,, Singles	28/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	26/-
,, ,, Splint	29/-
,, ,, Trebles	29/3
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	25/- to 29/-
Screened Navigation	32/6
Trebles	29/-
Doubles	28/-
Singles	28/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	28/-
Secondary Steam	26/6
Trebles	28/6
Doubles	28/-
Singles	28/-

ENGLAND.

(6) N.W. COAST—	
Steams	31/6
Household	46/6 to 57/6
Coke	48/-
NORTHUMBERLAND—	
Best Steams	32/6 to 35/-
Second Steams	31/6 to 33/6
Steam Smalls	22/6 to 25/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	33/- to 35/-
Second	31/6
Household	25/- to 28/-
Foundry Coke	70/- to 72/6

SHEFFIELD—	INLAND.	
Best Hand-picked Branch	32/6 to 34/6	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	25/6 to 27/6	—
,, ,, House	23/- to 24/6	—
,, ,, Large Nuts	20/6 to 22/6	—
,, ,, Small ,,	18/- to 21/-	—
Yorkshire Hards	22/- to 24/-	—
Derbyshire ,,	21/- to 24/-	—
Rough Slacks	12/- to 14/-	—
Nutty ,,	10/6 to 12/6	—
Smalls	7/- to 9/-	—
Blast Furnace Coke (Inland)		24/- to 27/-
,, ,, (Export) f.o.b.		44/- to 47/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	42/- to 43/-
Second ,, ,,	39/- to 40/-
Best Dry Large	38/- to 40/-
Ordinary Dry Large	35/- to 37/6
Best Black Vein Large	39/- to 40/-
Western Valley ,,	39/- to 40/-
Best Eastern Valley Large	37/- to 37/6
Ordinary ,, ,,	35/- to 37/-
Best Steam Smalls	30/- to 32/6
Ordinary ,, ,,	27/- to 29/-
Washed Nuts	30/- to 35/-
No. 3 Rhondda Large	38/- to 40/-
,, ,, Smalls	30/- to 34/6
No. 2 ,, Large	34/- to 36/-
,, ,, Through	30/- to 32/-
,, ,, Smalls	26/- to 28/-
Coke (export)	67/6 to 75/-
Patent Fuel	40/- to 42/6
Pitwood (ex ship)	30/- to 31/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	45/- to 47/6
Seconds	40/- to 45/-
Red Vein	32/6 to 35/-
Machine-made Cobbles	55/- to 60/-
Nuts	50/- to 52/6
Beans	45/- to 47/6
Peas	25/- to 26/-
Breaker Duff	12/- to 13/-
Rubbly Culm	17/- to 17/6
Steam Coals:	
Large	27/6 to 30/-
Seconds	25/- to 27/-
Smalls	20/- to 22/-
Cargo Through	22/6 to 25/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal.

French Engineering Notes.

(From our Correspondent in Paris.)

The Paris Fair.

THE annual Fair in Paris owes its popularity to the fact that it is a purely national exhibition of samples, and is therefore representative of French industry generally. Although in the engineering section it has lost some of its importance through the abstention of leading firms, the variety and character of the exhibits nevertheless conveys a good idea of the progress and development of French manufactures. While the agricultural machinery and heavy exhibits are relegated to the show yard in the Champs de Mars, the engineering exhibits are displayed in a vast temporary building formed of a number of bays. The prominence given to electrical appliances and machinery is the result of the electrification activity throughout the country, where the laying down of hydro-electric and heat plants is preparing the way for the almost universal use of electricity for power purposes. Electrical engineering is developing more rapidly than any other branch, and the applications at the Fair are practically unlimited, alike for domestic, industrial and agricultural uses.

An Electric Boiler.

The Société de Constructions Mécaniques of Mulhouse is showing at the Fair an electric boiler on the Bergeon-Fredet system for raising steam with alternating current. On condition that the cost is low enough, it is obvious that the generation of steam by electricity would offer great advantages in the way of rapidly getting up steam, of adjusting steam pressure and of reducing the cost of labour. It is claimed that a kilowatt produces from 1.2 kilos. to 1.5 kilos. of steam. To permit of a comparison between coal and electricity, it is stated that the cost of a ton of steam produced in the electric boiler is equivalent to the cost of 770 to 800 kilowatt-hours. The system consists essentially of a boiler and an electric heater, the latter being placed below the level of the boiler. The two components are connected by two pipes, one conveying water from the bottom of the boiler to the bottom of the electric heater in which are a number of electrodes, and the other taking steam from the top of the generator through the upper part of the boiler and down into the volume of water. The working of the system depends upon the automatic maintenance of the water level in the electric heater. This is assured by the resistance in the water and steam pipes, adjusted permanently by valves below and above the electric heater, while the automatic action is obtained by a servo-motor actuating a valve on the steam pipe above the level of the boiler through the medium of a pipe from the boiler steam space. The steam pressure in the boiler is therefore prevented from rising by throttling the steam pipe and reducing the water level in the electric heater, so that a smaller quantity of water is in contact with the electrodes. The volume of water in the electric heater is thereby automatically adjusted for the quantity of steam required. Another advantage claimed for the electrical generation of steam is that surplus current can be employed for the purpose and the steam may be stored in the form of hot water in accumulators or in ordinary boilers.

Labour-saving Appliances.

While the high cost of fuel in this country is turning attention to the more general application of electricity, the scarcity of labour and the high wages are giving more importance to labour-saving devices of all kinds. This is observable more especially at the Paris Fair in electric domestic appliances, and also in the use of compressed air tools with portable air-compressing sets actuated by petrol or electric motors. Portable pumping sets and various labour-saving devices for roadmaking and for industrial purposes generally show that everything is being done to combat steadily increasing costs by dispensing with labour as much as possible. This is also observable in the types of universal machines being put on the market for the convenience of small manufacturers. Especially is this the case in wood-working machinery, which has undergone considerable extension during the past few years, while one firm at Auxerre claims to have the largest works devoted to wood-working machinery in the world. Nevertheless, it cannot be said that the French makers are turning out machines of such high efficiency as those manufactured by certain British firms, but they are generally well made and cover a wide range, while those exhibited at the Fair are mostly for sawing, planing, morticing and for making wheel spokes and the like. One firm exhibits a heavy electric hand plane. There appears to be nothing at the Fair to compare with British machines for the highest class work. In machine tools the exhibits are not so large as they were last year, but in lathes, milling machines and drilling machines there are a few novelties, notably the portable drilling machine of the Société Alsacienne de Constructions Mécaniques of Belfort. This is a heavy machine mounted on rollers for bringing it up to the work and is held in position by screw jacks. There is an increasing number of mono-pulley lathes with electric motors, and M. H. Ernault, who has always occupied a leading position as a manufacturer of lathes, is making a speciality of improved types of boring machines. A great deal of progress is undoubtedly being made in the design and construction of machine tools, from automatic lathes for light repetition work to the heaviest boring mills, and in this department French manufacturers seem to be quite capable of commanding the home market so long as prices are in their favour. Nevertheless, there is always an opening in this country for special machine tools of foreign make. Amongst other exhibits, a novelty that may be mentioned is an air filter composed of a number of perforated plates, the plates being arranged one behind the other, so that the perforations do not coincide. As the air passes through a number of these plates, it has to take a zigzag course, and on each plate a proportion of the dust is deposited, until, on leaving the last plate, it is free from solid impurities.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

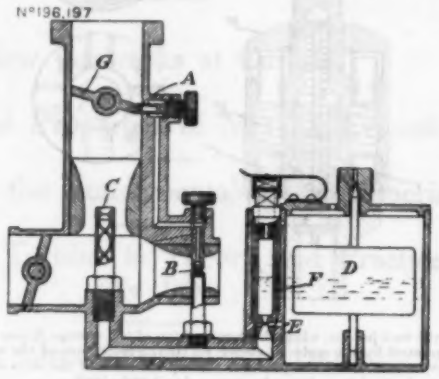
The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

196,197. May 16th, 1922.—CARBURETTERS, C. Wirsum, Paulsbornerstrasse 1, Berlin-Halensee, Germany.

In this rather elaborate carburetter there are three jets—A for running the engine light, B for partial loads, and C for full load. The fuel is supplied from a normal float chamber D by way of the passage E that leads into the hollow plug F. The hollow of this plug communicates with the atmosphere at the

N°196,197



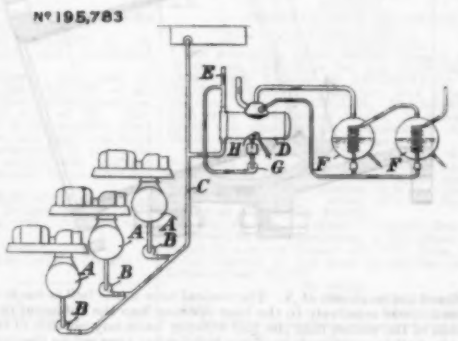
top. When the engine is started with the throttle G closed the rush of air past the end of the jet A produces such a vacuum that fuel is sucked up the jet B, jumps right across the opening into the passage above, and thus to the jet A. When the throttle is opened the vacuum at A is reduced, so that that jet goes out of action and the jets B and C come into operation successively. —*April 19th*, 1923.

CONDENSERS AND FEED-WATER HEATERS.

195,783. January 12th, 1922.—DE-AERATING FEED WATER, H. Fothergill, 3, Central-buildings, Westminster, S.W. 1.

The condensate from the condensers A is discharged by the pumps B into the feed system C, from which the water is delivered through the evaporator heater D to the boilers through the pipe E. The steam generated by the evaporating plant F is condensed in the heater D, the water therefrom being discharged by

N° 195,783



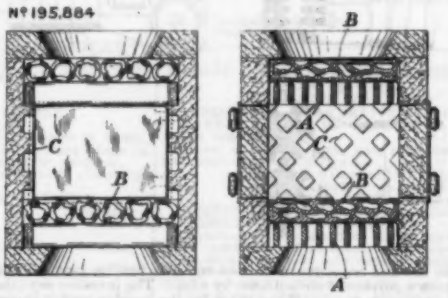
the pump G into the pipe E. The heater D is maintained under partial vacuum by the air ejector H, whereby the condensed water in the heater is subjected to a pressure which approximately corresponds to the temperature of the water; thus the contained gases are liberated and the water can be withdrawn and supplied to the boilers in a de-aerated condition. Several modifications are described.—*April 12th*, 1923.

FURNACES.

195,884. May 11th, 1922.—HARDENING FURNACES, R. Wicksteed, Stamford Road Works, Kettering.

The inventor claims that this furnace can be raised to a high temperature more quickly than one of ordinary construction. The top and bottom each have large openings and grids of fire-

N° 195,884



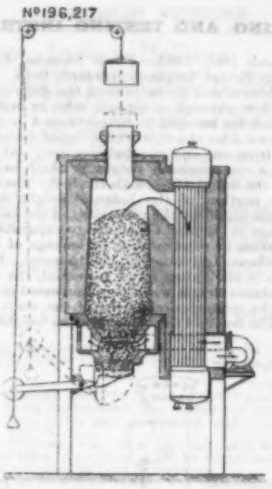
brick A A are arranged to bridge them. On these grids layers of "asbestos gas fuel" B B are laid. The sides of the furnace are provided with projections C, which become incandescent comparatively quickly.—*April 12th*, 1923.

GAS PRODUCERS.

196,217. August 2nd, 1922.—COOLING COKE, *B. E. D. Kilburn*, 31–33, *High Holborn, London, W.C.* 1.

This invention relates to that form of coke cooler in which inert gas is circulated by a fan through the coke and a boiler. It is, of course, necessary to open the chamber occasionally to charge and discharge the coke, but the inventors say that experiment has proved that so long as the circulating cycle is placed in communication with the atmosphere only at a single point no fresh air enters and none of the cooling gases escape. It is practically immaterial at what point in the cycle the opening is made, as the necessary pressure conditions are automatically produced

N°196,217



whether the opening is in front of the fan or behind it. If, however, the cycle is disturbed simultaneously at more than one point, cooling gas will escape through one opening and cold air will enter through the other, thus leading either to loss of heat or to excessive combustion of coke, with the consequent formation of carbon monoxide wherever air enters. To prevent unintentional opening of the charging and discharging apertures at the same time, these members are preferably positively connected so that it is impossible to open one without closing the other. The illustration shows one method of interlocking the inlet and outlet doors.—*April 19th*, 1923.

TELEGRAPHS AND TELEPHONES.

195,814. February 3rd, 1922.—IMPROVEMENTS IN AND RELATING TO VARIABLE INDUCTANCES FOR WIRELESS RECEPTION APPARATUS, Gordon Gastagnoli, of 15, Rayne-road, Braintree.

The variable inductance described in this specification consists of a cylindrical helically wound induction coil A and a

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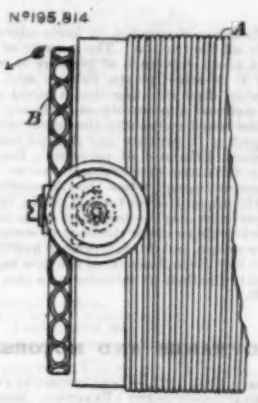

basket coil B arranged so that it can revolve within the coil A. The inductance coil A may, if necessary, have several layers of banked winding instead of a single layer as shown.—*April 12th*, 1923.

189,095. November 4th, 1921.—IMPROVEMENTS IN THERMIONIC GENERATORS, Gesellschaft für Drahtlose Telegraphie m.b.H., of 9, Tempelhofer Ufer, Berlin, S.W. 11, Germany.

When a thermionic valve is employed for the generation of electric oscillations it is necessary that the anode current should

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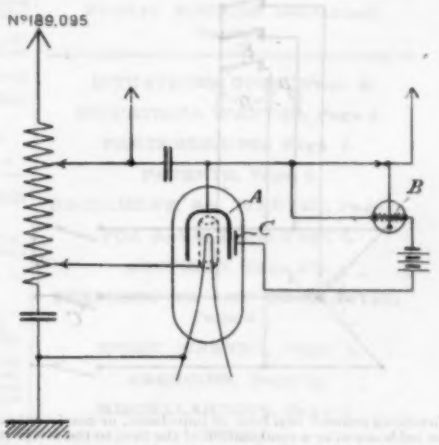


not be allowed to become great enough unduly to heat the anode. Usually the anode should show hardly any indications of heat, and at most should be brought to a dull red heat; other-

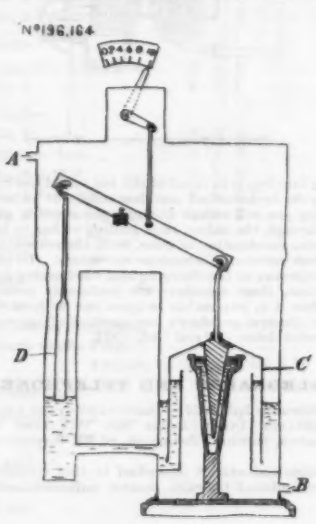
wise the valve may be destroyed. According to this invention an auxiliary electrode is fitted in the valve to which electrons emitted by the anode (owing to its becoming overheated) may pass, and to this electrode a relay is connected to interrupt or reduce the feed current. If the anode A is normally loaded so that it does not glow no current passes through relay B. On the other hand, if for any reason the working condition is disturbed and the anode A glows, it emits electrons which are collected by the auxiliary anode C, anode A thus acting as a cathode for the current path of the relay. A current depending on the temperature of the anode therefore passes through relay B. The contacts D are therefore separated and the main feed circuit is broken.—*April 19th*, 1923.

MEASURING AND TESTING INSTRUMENTS.

196,164. March 18th, 1922.—FLOW METERS, J. L. Hodgson, Eggington House, Leighton Buzzard, Beds.

This is an instrument for measuring the difference in pressure caused by a flow through a venturi tube or orifice. The two pressures, which are brought to connections A and B, are caused to act on the two sides of a thin-walled liquid-sealed bell C, which is suspended from one end of a balance arm. At the other end of the arm is a compensating weight D which balances the bell and dips into the liquid which seals the bell. The cross-sectional area of that portion of the balance weight which may be immersed in the liquid by the movement of the bell is made such that any change in the liquid level due to expansion of the liquid or to evaporation or condensation or leakage of liquid will not disturb the balance and cause the bell to move. For instance, if the two parts of the balance arm are equal, the cross-sectional area of the balance weight where it is immersed in the liquid will be equal to the cross-sectional area of the walls of the liquid-sealed bell. The bell and the compensating weight and the beam

N°196,164



which carries them are suspended on knife edges. This eliminates practically all the friction. The amount of motion of the sealed bell for a given difference of pressure is controlled by a float or weight E attached to the balance arm. If a float is used, it preferably dips into mercury, a liquid which does not evaporate or condense appreciably at ordinary temperatures. The float and the vessel containing the liquid into which it dips may be so shaped as to produce any desired movement of the bell for any given difference of pressure. For instance, the movement may be made proportional to the square of the difference of pressure except when the difference of pressure is very small, or the amount of movement of the bell at the small differences of pressure may be increased even more than this. It is usually preferable to make the float of some simple shape, such as a cone or wedge, and if this is done, a motion proportional to the flow or to any given function of the flow may be obtained from the motion of the float by introducing a cam mechanism.—*April 19th*, 1923.

DYNAMOS AND MOTORS.

196,068. January 12th, 1922.—IMPROVEMENTS IN THE CONTROL OF ALTERNATING-CURRENT ELECTRIC MOTORS, William Andrews Tester, of The Corner House, Commissioner-street, Johannesburg, Transvaal, South Africa; and Sydney Thompson, of City House, Main-street, Johannesburg.

This invention has for its object to prevent the stresses or shock caused in the winding and mechanical parts of a motor when connecting it to the electric power supply, and at the same time to prevent the voltage rise at the stator terminals when the motor is disconnected from the power supply. The

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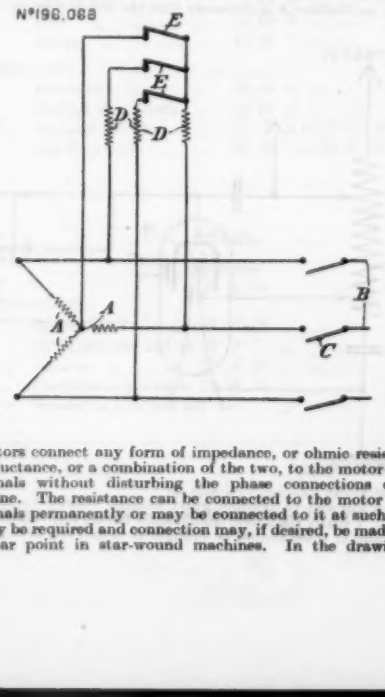

inventors connect any form of impedance, or ohmic resistance, or inductance, or a combination of the two, to the motor stator terminals without disturbing the phase connections of the machine. The resistance can be connected to the motor stator terminals permanently or may be connected to it at such times as may be required and connection may, if desired, be made with the star point in star-wound machines. In the drawing A denotes the stator of the motor, B the mains, and C the main switches. D represents the resistances and E the star point switches shown closed.—*January 12th*, 1923.

MACHINE TOOLS AND SHOP APPLIANCES.

196,194. May 11th, 1922.—TAPPING CHUCKS, Sir A. Herbert, Dunloy Manor, near Whitchurch, Hants, and A. H. Lloyd, 33, Styvechale-avenue, Coventry.

In this slipping chuck for tapping work the drive is transmitted from the shank A to the tool holder B by the spring plungers C C. These plungers engage with sloping sided slots D

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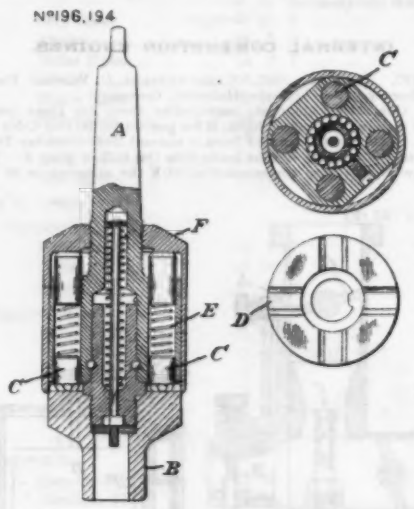

in the tool holder, while the compression of the springs E can be regulated by the screwed sleeve F. If the resistance of the tap becomes excessive the plungers ride up the sides of the slots and save the tool from being broken.—*April 19th*, 1923.

TRANSMISSION OF POWER.

195,772. January 10th, 1922.—BALL AND SOCKET PIPE JOINTS, W. H. Dorman and Co., Limited, 43, Foregate-street, Stafford, and O. H. G. Steed, 88, Tixall-road, Stafford.

This ball and socket joint is intended for suction piping systems dealing with solid matter, such as sand, grain, or coal. In order to prevent the spherical surface of the socket being cut by the material handled, the bore of the ball part of the joint is

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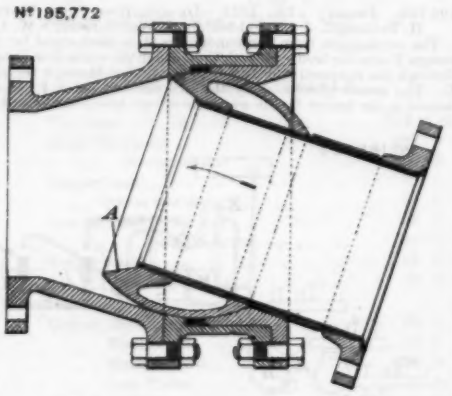

flared out as shown at A. The conical bore in the ball is made of such a size relatively to the bore opening into the spherical portion of the socket that the ball will not leave any portion of the spherical bearing surface of the ball socket exposed to the contents of the pipe when the joint is bent to its angle of limit.—*April 10th*, 1923.

MISCELLANEOUS.

195,731. January 3rd, 1922.—A COTTON PICKING MACHINE, F. W. Stukenborg, 5347, Prairie-avenue, Chicago, Illinois.

This cotton picking machine comprises a pair of hog bristle brushes A A driven by a small electric motor B, through worm gears, at a speed of from 1800 to 2500 revolutions per minute.

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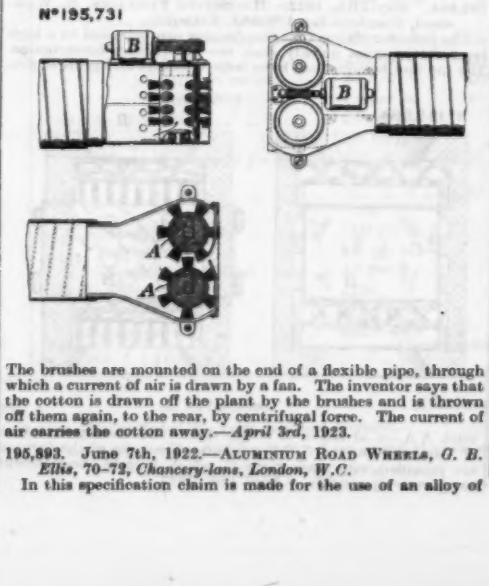

The brushes are mounted on the end of a flexible pipe, through which a current of air is drawn by a fan. The inventor says that the cotton is drawn off the plant by the brushes and is thrown off them again, to the rear, by centrifugal force. The current of air carries the cotton away.—*April 3rd*, 1923.

195,893. June 7th, 1922.—ALUMINIUM ROAD WHEELS, *G. B. Ellis*, 70–72, *Chancery-lane, London, W.C.*

In this specification claim is made for the use of an alloy of aluminium in the construction of motor car wheels. The alloy consists of 94 per cent. of aluminium, 0.5 per cent. magnesium, and 5.5 per cent. of chromium, manganese and copper in varying proportions. After forging and heat treatment the alloy

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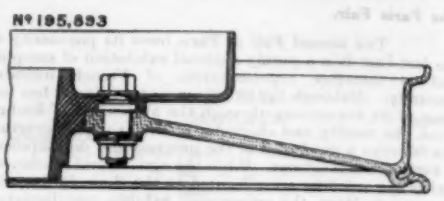

is said to have a tensile strength of from 55,000 lb. to 60,000 lb. per square inch. The drawing, one of several, shows a disc wheel with a cast steel hub and brake drum, the remainder being of the alloy.—*April 12th*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "Recent Studies in Alternating Magnetism," by Mr. W. M. Mordey. 9 p.m.

SATURDAY, MAY 19TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Eastern District meeting at Peterborough. 10.30 a.m.

TUESDAY, MAY 22ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Paper, "Ball Bearings," by Mr. A. Macaulay. 6.45 p.m.

THURSDAY, MAY 24TH.

INSTITUTION OF STRUCTURAL ENGINEERS.—Denison House, 296, Vauxhall Bridge-road, S.W. 1. Annual general meeting. Paper, "Some Recent Tests on Concrete and Earth Pressures," by Dr. Oscar Faber. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Engineering Problems Solved by Photo-elastic Methods," by Professor E. G. Coker. 3 p.m.

FRIDAY, MAY 25TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Development of London," by Sir Aston Webb. 9 p.m.

SATURDAY, MAY 26TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Eastern District meeting at Southend-on-Sea. 10.45 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Western District meeting at St. Austell, Cornwall. 11.15 a.m.

MONDAY, MAY 28TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Loughborough graduates' meeting. Paper, "The Design of Connecting-rods for High-speed Engines," by Mr. M. Platt. 7 p.m.

THURSDAY, MAY 31ST.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Annual general meeting. 6 p.m.

TUESDAY TO FRIDAY, JUNE 5TH TO 8TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer meeting at Manchester. For programme see page 322.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ALFRED HERBERT, Limited, Coventry, have appointed the Wellman Smith Owen Engineering Corporation, Limited, 36-38, Kingsway, London, W.C. 2, sole concessionnaire for the United Kingdom for the sale of the "Atritor" fuel drying and pulverising machine for use with metallurgical furnaces.

BEYER, PEACOCK AND CO., Limited, of Gorton, Manchester, have removed their London office from 15, Dean's-yard, to Abbey House (Rooms 338–340), Westminster, S.W. Mr. W. C. Williams will act as their representative.

HENRY BERRY AND CO., Limited, of Leeds, inform us that they have opened an office in Central House, 75, New-street, Birmingham. Telegrams, "Rivetter, Birmingham." Telephone No. 4317 Central, Birmingham.

CONTRACTS.

DANIEL ADAMSON AND CO., Limited, of Dukinfield, have received from the High Commissioner for the Union of South Africa an order for the supply of a complete electro-pneumatic sewage lifting plant, automatically controlled by float switch-gear for Durban.

THE PATERSON ENGINEERING COMPANY, Limited, of Windsor House, Kingsway, London, W.C. 2, has recently received from the Burgh of Kilmarnock an order for an installation of its rapid air-cleansed gravity filters of 3,000,000 gals. daily capacity, including water turbines, chemical treatment plant, sedimentation tanks, filters, and all the necessary auxiliary equipment: and from the Malvern Council an order for an installation of pressure filters of 500,000 gals. daily capacity, comprising four 8ft. diameter filter units with air cleansing arrangements.

ROYAL INSTITUTION.—The general monthly meeting of the members of the Royal Institution was held on Monday afternoon, May 7th, the Duke of Northumberland, president, in the chair. Sir J. J. Thomson was elected Honorary Professor of Natural Philosophy, and Sir Ernest Rutherford Professor of Natural Philosophy. It was announced that the Duke of Northumberland, president, had nominated the following gentlemen as vice-presidents for the ensuing year:—Dr. Mitchell Bruce, Lord Iveagh, Sir Edward Pollock, Lord Rothschild, Sir Alfred Yarrow, the Right Hon. Lord Justice Younger, Sir James Crichton-Browne treasurer, and Sir Arthur Keith secretary. Dr. P. J. Le Riche and Dr. Liebert were elected members.